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Volume I

Report
Tables, Figures

**Remedial Investigation
National Smelting of
New Jersey, Inc./
NL Industries, Inc. Site**

**Pedricktown,
New Jersey**

**NL Industries, Inc.
Hightstown, New Jersey**

October 1990



O'BRIEN & GERE

2844.014

REPORT

REMEDIAL INVESTIGATION
NATIONAL SMELTING OF
NEW JERSEY, INC./NL INDUSTRIES, INC. SITE
PEDRICKTOWN, NEW JERSEY

OCTOBER 1990

PREPARED BY:

O'BRIEN & GERE ENGINEERS, INC.
440 VIKING DRIVE
VIRGINIA BEACH, VIRGINIA 23452

NLI 001 1395

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EXECUTIVE SUMMARY

The Pedricktown, New Jersey site (Site) is the location of a former secondary lead smelting facility. Metal smelting, refining and associated activities have been conducted at the Site since the facility was constructed in 1971-1972 until operations ceased in January 1984. This Remedial Investigation Report presents the results of field investigations conducted at the Site in accordance with the approved Work Plan and Site Operations Plan as well as an evaluation of the effect of the field conditions on human health. This Executive Summary provides a brief overview of the findings which are discussed at length within the body of this Remedial Investigation Report.

An inventory of bulk and containerized materials at the plant was conducted to quantify the amounts and the location of these materials. Samples of the unknown and some known materials were taken to evaluate appropriate management approaches of the materials. It was determined that approximately 7500 cubic yards of lead-bearing materials are located on-site in the battery bins and other uncontrolled areas. Approximately 1200 drums containing lead-bearing material were identified within the plant area. Solid materials within the manufacturing area generally contain 20% lead with a low of <1% to a high over 50%. Portions of the rotary kiln slag in the manufacturing area are EP Toxic with an average total lead concentration of about 10%. Within the manufacturing area there is approximately 480,000 gallons of rain water that has

collected in trenches, pits and depressions around the plant facility.

Surface water and sediments from the two streams on adjacent properties were examined. Surface water in the stream along the west edge of the property (West Stream) contained lead concentrations ranging from 0.049 mg/l to 2.2 mg/l. Sediment samples (0-3") in the West Stream ranged in total lead concentration from 171 mg/kg to 23,700 mg/kg with a geometric mean of 1400 mg/kg. The lead concentration in sediments decreases dramatically with depth in the West Stream, with the mean lead concentration below 12 inches of 15 mg/kg. Surface water in the stream on adjacent properties to the east (East Stream) contain a lead concentration that ranged from 0.01 mg/l to 0.101 mg/l. Surface sediments (0-3") lead concentrations ranged from 13.9 mg/kg to 628 mg/kg with a geometric mean of 110 mg/kg.

Soil samples were collected from several on-site and off-site locations. On-site soils contained lead at concentrations that ranged from 12 mg/kg to 12,700 mg/kg. Off-site surface (0-3") soils ranged in lead concentrations from 22 mg/kg to 685 mg/kg, with the exclusion of one anomolous location. Samples at twenty locations within 500 feet of the property boundary averaged approximately 210 mg/kg of total lead. The lead concentration in off-site soils from 3-6 inches below grade show a substantial reduction in lead concentration ranging from 11.5 mg/kg to 382 mg/kg.

A number of geologic field investigations were conducted at the site. As part of these investigations, ground water samples were collected from on-site monitoring wells and off-site private potable wells along U.S. Route 130. There are three aquifers that are monitored by wells around the site as follows: unconfined, first confined and second confined.

Unconfined aquifer wells closest to the manufacturing area of the plant generally have the highest concentration of metals. Cadmium and lead are the metal contaminants found at elevated concentrations in the on-site unconfined aquifer. Analysis for radionuclides did not indicate a radionuclide source at the site. Wells solely within the first confined and second confined aquifer and off-site monitoring wells hydraulically downgradient do not contain concentrations of analytes above USEPA MCL's. Private potable wells along U.S. Route 130 north of the landfill also meet USEPA drinking water standards for the analytes tested.

The study also examined mechanisms by which contaminants could be transported from the site. These transport mechanisms include air, surface water, and ground water. The migration of lead-bearing materials off-site via air is not a significant transport route. Surface water runoff from the plant drains to the West Stream. Ground water flow of the unconfined aquifer is to the northwest. The clay layer between the unconfined and first confined aquifer may not be continuous and may allow contaminants to enter the first confined aquifer. Ground water flow in the first confined aquifer appears to be controlled by off-site pumping

of the aquifer to the west. The first and second confined aquifers are separated beneath the site by a clay layer which prevents the migration of contaminants into the second confined aquifer. Ground water flow of the second confined aquifer appears to be easterly toward industrial process water wells on adjacent industrial properties.

The Risk Assessment addresses potential human risks associated with chemicals in the ground water, soil, surface water and wastes. The major exposure pathway controlling the Risk Assessment is ground water. The Risk Assessment found that current risks to human health using the USEPA approved methodology is within the Superfund Site Remediation Goal in the National Contingency Plan. Future risks are not within the Superfund Site Remediation goals because USEPA methodology assumes that on-site ground water quality will be the source of a home owners potable supply. O'Brien & Gere believes this is an unrealistic assumption given hydrogeologic conditions at the site and availability of potable water at the site.

The field investigations generated some anomalous results. Supplemental field investigations are recommended to better define the extent of contamination in selected media. In addition, an environmental review has been recommended.

SECTION 1 - INTRODUCTION

1.01 Purpose of Report

The purpose of this Remedial Investigation (RI) Report is to present information that has been gathered from the National Smelting of New Jersey, Inc./NL Industries, Inc. (NSNJ/NL) site in order to support an informed risk management decision regarding an appropriate remedy for the site. This RI was prepared in accordance with the Administrative Order on Consent of April 30, 1986 between NL Industries, Inc. and the United States Environmental Protection Agency (USEPA) and the USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (October 1988). The field investigations were conducted at the site in accordance with the Remedial Investigation/Feasibility Study (RI/FS) Work Plan, which was approved by the USEPA on June 17, 1987 and the RI/FS Site Operations Plan, which was approved by the USEPA on May 26, 1988.

1.02 Site Description

The site is located in an industrial park bounded by U.S. Route 130, Porcupine Road, Pennsgrove-Pedricktown Road, and Benjamin Green Road as illustrated in Figure 1. The site which occupies approximately 68 acres is divided into a northern section and southern section by railroad tracks. The northern section includes a closed RCRA landfill, an office trailer, and leachate holding tank. The southern section includes the factory complex, and landfill access road. An aerial photograph and other

photographs are provided as Exhibit G. A more detailed description is provided in Section 3.01.

1.03 Site History

The Pedricktown secondary lead smelter was constructed in 1971-1972 to recycle automotive batteries and baghouse fines in the area illustrated on Figure 1. The smelter originally made use of a blast furnace and a reverberatory furnace for smelting. A sweater furnace was also on-site for melting of metallic lead scrap. The Pedricktown facility was upgraded to incorporate systems that would do the following:

- a. Take a tractor-trailer loaded with scrap batteries and dump the scrap batteries into an acid brick lined bin by inclining the tractor-trailer to a sixty degree angle on a hydraulic ramp.
- b. Crush the batteries.
- c. Separate the plastic/rubber case materials, metallic lead, and lead compounds for recycling.
- d. Smelt lead-bearing materials (i.e. a rotary kiln) with minimal emissions of sulfur oxides.

A detailed drawing of the plant area showing major pieces of equipment and production areas is presented in Figure 2.

NL Industries, Inc. (NL) constructed a landfill on its Pedricktown facility's property. Figure 3 shows the location of the landfill, which consists of two phases - Landfill Phase A and Landfill Phase B. Landfill Phase A contains process wastes (blast furnace and kiln slag) from the facility, while Landfill Phase B also contains hard rubber case material and lead contaminated soils

that were excavated from the facility's grounds. The landfill was constructed with a double liner system which includes a primary membrane liner and a secondary asphaltic liner. The liner system includes leachate collection and withdrawal sumps. Each phase has a primary liner sump and a secondary liner sump. For this report, the terminology used will be A primary, B primary, A secondary, and B secondary. Exhibit A of the approved Work Plan (O'Brien & Gere, 1987) and Exhibit L provide additional detail on the landfill construction.

NL Industries, Inc. (NL) terminated lead smelting May 25, 1982. On October 6, 1982, NL signed an Administrative Consent Order (ACO) with the New Jersey Department of Environmental Protection (NJDEP) whereby NL agreed to undertake a variety of activities in order to address environmental conditions at the Site. In anticipation of the transfer of the property to National Smelting of New Jersey (NSNJ) the order was amended on February 10, 1983 to distribute the responsibilities for the various activities between NL and NSNJ.

Prior to the sale to NSNJ, NL washed all paved surfaces in the manufacturing area and cleaned soils around the plant by removing the soils to a depth of 12 inches (Exhibit G and Exhibit M). NL retained Geraghty & Miller, Inc. to design a ground water abatement system. The ground water abatement system was installed by Ground Water Technology/Moretrench America. The objective of the ground water abatement system is to prevent the off-site migration of contaminated ground water if remediation of the unconfined aquifer

is required. NL retained Roy F. Weston to design and oversee closure of the on-site RCRA Landfill in accordance with the Amended Order.

NSNJ purchased the smelter from NL and took possession of the Pedricktown property on February 24, 1983. NSNJ commenced rotary kiln smelting on May 20, 1983. NSNJ then operated the smelter until January 20, 1984. NSNJ's process attempted to recycle all types of lead-bearing materials as indicated by the materials remaining at the site when the site was abandoned by NSNJ. During the operation of their Pedricktown facility by NSNJ, NSNJ allowed slag waste from their processing of lead, along with other bulk, drummed and/or containerized waste materials and raw materials (including ore concentrates, fluxes and reagents) to accumulate in non-enclosed areas that were exposed to the elements. NSNJ filed for bankruptcy under Chapters 11 and 7 on March 5th and 27th, 1984 respectively.

Following bankruptcy filing, the National Bank of Georgia, (Trustee for the holders of New Jersey Economic Develop Authority Bonds issued to finance the operations of NSNJ) stationed personnel at the Site for site security and landfill maintenance. The National Bank of Georgia ceased landfill maintenance June 15, 1984. NL voluntarily entered the Site on June 18, 1984 to pump landfill leachate which had accumulated in the leachate sumps, and to maintain landfill cover materials. The National Bank of Georgia ceased security services August 31, 1985 and abandoned the Site.

NL has continued to maintain landfill cover materials and to remove leachate from the landfill facility since 1984. These maintenance activities included two landfill remedial projects to address the impact of adverse weather conditions upon the landfill.

In July 1988, the extremely hot and dry weather during the late spring and early summer contributed to the drying and cracking of the clay cap, allowing a seep to occur. The following remedial activities were undertaken:

- A. An interceptor trench was installed along the landfill perimeter where seeps were identified or suspected to prevent any potential release of leachate into the environment.
- B. A 40 mil High Density Polyethylene (HDPE) membrane was placed over the entire landfill plateau to eliminate any rain water infiltration through the clay cap.
- C. Twenty-one piezometers were installed per the recommendations of R.F. Weston, to aid in defining the landfills' conditions and aid in expediting the removal of leachate from the facility via an automatic piezometer pumping system.
- D. An improved drainage system for the vegetated cover materials was provided in conjunction with an improved service road.

The July 1989 100-year storm (in excess of 6-inches of rain in 6 hours) fluidized the soil cover materials along the steeper side slopes. This led to the following actions undertaken by NL:

- A. The affected side slope soil materials were replaced with a 40-mil HDPE membrane/stone cover system which was placed above the pre-existing clay cap and interfaced with the plateau membrane system.
- B. The interceptor trench was upgraded, becoming an integral part of the side slope membrane system including a leak detection system, and was extended along the entire landfill perimeter that was affected during this storm event.

- C. Leachate transfer systems were upgraded to provide for multiple backup facilities.

The USEPA, Region II, and the New Jersey Department of Environmental Protection were notified of the above conditions and were consulted regarding the construction activities at the landfill.

1.04 Previous Investigations

Several studies were conducted from 1980 through 1987 involving on-site soils, surface water, and ground water. Previous studies regarding bulk and containerized solids are limited to analyses of rotary furnace slag (Exhibit H). Analyses were conducted on the landfill leachate (Exhibit A).

A soil sampling program was completed by NL in early 1981 which was conducted in response to NJDEP requests for information. The samples were obtained in late 1980. Sample locations from this study and results were presented in the Remedial Investigation Feasibility Study (RI/FS) Work Plan (O'Brien & Gere, 1987). These analyses were the basis for NL's excavation and disposal of plant soils prior to the sale of the facility to NSNJ in 1983. The excavated soils were placed in the on-site RCRA landfill which was certified closed on December 15, 1983 in accordance with the NJDEP approved closure plan.

Water samples were collected at various times during the period from 1981 through 1983 and analyzed for a variety of parameters. The analytical results for these samples are presented in the Work Plan (O'Brien & Gere, 1987).

A hydrogeologic study of the Site was performed by Geraghty & Miller, Inc. to develop a conceptual design of the ground water abatement system (Geraghty & Miller, 1983). Their study involved the installation of 30 wells. Split spoon samples and Shelby tube samples were obtained to examine the underlying lithology.

NL contracted Roy F. Weston, Inc. (RFW), the professional engineers who designed and supervised the closure of the landfill, to evaluate the status of the landfill in 1987. RFW reaffirmed the integrity of the clay cap and determined that the leachate recovery system had been restricted with a build-up of solids, which could have resulted from insufficient leachate withdrawal by NSNJ between December 22, 1983 and June 15, 1984. RFW recommended the installation of piezometers in the landfill to provide a means of evaluating leachate levels within the facility. These piezometers were installed in the summer of 1988.

1.05 Report Organization

NL Industries, Inc. agreed, in an Administrative Order on Consent with the U.S. EPA, to conduct a Remedial Investigation (RI) Feasibility Study (FS) effective on April 30, 1986. The Report is organized into eight sections which address work completed at the Site as follows:

Section 1 presents information on Site history and previous studies of the Site.

Section 2 presents information about field activities and methodology used to obtain information about the physical and chemical characteristics of the Site and the surrounding areas.

Section 3 presents the physical characteristics of the Site and surrounding areas as determined by the field activities conducted during this remedial investigation.

Section 4 presents the results of the laboratory analysis which are performed on samples from the study area in order to characterize the contaminant concentration levels in various environmental media.

Section 5 presents a discussion concerning the transport and extent of contamination with the study area.

Section 6 presents a discussion of public health and environmental impacts. The section identifies potential receptors that may be affected by the observed environmental conditions, and summarizes public health and environmental concerns associated with the observed environmental conditions.

Section 7 presents a summary and brief conclusions of the results of the investigative activities conducted at the Site and presents recommendations for further action.

Appendices and exhibits are included in Volume II to assist the reader in understanding the complex issues involved in the program.

SECTION 2 - STUDY AREA INVESTIGATION

2.01 Surface Features

A topographic survey was conducted of the site by Albert Fralinger, Jr., PA, in May 1990. The survey incorporated elevations of the unpaved areas around the plant, the landfill, and neighboring properties in the immediate vicinity of the site. The survey also identified the locations of ground water wells, stream, buildings, roads and utilities.

2.02 Contaminant Source Investigation

The NSNJ, Inc. operation resulted in the accumulation of raw materials and wastes at the Site. Photographs presented in Exhibit G illustrate the plant area before and after the NSNJ, Inc. operation. An inventory of these materials was conducted to quantify the amounts of these materials present at the facility and to identify their locations on the Site (Table 1 and Figure 2). Mr. Stephen W. Holt, the Site Manager of Environmental Control and Safety for NL Industries from March 1979 to February 1983, (Mr. Holt is still an employee of NL) assisted in identifying materials during the inventory.

Representative samples of bulk and containerized materials identified at the facility were collected, with the exception of labeled containerized raw material and specifically identifiable bulk materials (i.e. new refractory brick, used baghouse bags and lead oxide pellets, etc.). The bulk and containerized solids consist of: slag, equipment residue and containerized solids (i.e.

baghouse dust, miscellaneous process waste and raw materials). These materials are present in the plant area and warehouse.

Analyses were run on the samples of unidentified materials and identified materials to determine appropriate management approaches. Knowledge of the composition and characteristics of identified materials were utilized in lieu of analysis. For example, lead oxide pellets are readily identifiable as are baghouse bags. Only total lead analysis were conducted on the equipment residue samples, since they are essentially raw and intermediate materials and will likely be recycled.

The following samples were collected using a carbon steel hand trowel, following the protocol outlined in the approved Site Operations Plan (O'Brien & Gere, 1988).

- three composite slag samples, one each from the slag bins, battery storage bins, and dross bins;
- eight equipment residue samples; and
- twenty-nine containerized solids samples.

Total lead analysis was conducted on all bulk and containerized solids samples. The EP toxicity test for all metals listed in 40 CFR 261.24 was performed on all slag samples. In addition, metal analyses for the following metals: antimony, arsenic, cadmium, chromium, copper, selenium, tin, and zinc were conducted on unknown bulk and containerized solids samples.

The liquid volume of stormwater and waste water contained in the following areas was estimated: a pond on asphalt pavement at the east side of the plant area, a pond on concrete pavement in the

center of the plant area, an acid pit, a thickener pit, and various storage tanks.

One sample was taken from each of the storage areas/facilities identified as holding storm or waste water (Table 1). If the liquid depth at the sample location was greater than three feet, a depth compositing technique was used to obtain the samples. Otherwise, grab sampling techniques were used to obtain the samples. Rain water accumulations in uncovered drums were pumped to a storage container and sampled as a composite. The uncovered drums were covered or inverted after pumping off the accumulated rain water. Each sample taken was analyzed for pH, lead and total organic carbon (TOC).

Leachate was collected from the on-site landfill in October, 1989. One sample was collected from each of the sumps (A primary, A secondary, B primary, and B secondary) for a total of four samples. Samples were collected by inserting Tygon tubing into the sumps and drawing the sample directly into the sample container by vacuum. Several analyses were performed on the leachate samples as identified on Table 6. Target Compound List (TCL) semi-volatile and pesticide organic analyses were performed on samples from the Phase B primary and secondary sumps of the on-site landfill.

2.03 Surface Water and Sediment Investigation

An unnamed tributary to the Delaware River is located along the western property boundary. This unnamed stream is called the West Stream in this Report. A second stream, referred to as the

East Stream, runs approximately 1000 feet east of and parallel to the Site's eastern property boundary. The East and West Streams merge north of Route 130 and ultimately discharge to the Delaware River. Figure 5 illustrates the approximately locations of these streams.

Sampling was conducted of both the West and East Streams during 1988 and again in 1989. The scope of the 1989 sampling was broadened to address questions raised during the interpretation of the 1988 data. In order to characterize surface water quality, samples were obtained upgradient of the Site, on or adjacent to the Site, and downgradient of the Site. Surface water and sediment samples were obtained in accordance with the protocol presented in the approved Site Operations Plan (O'Brien & Gere, 1988).

All surface water samples collected in 1988 were analyzed for pH and total lead. Surface water samples in 1988 were obtained during both high flow and low flow stream conditions where flowing water was present at the locations illustrated on Figure 6. Two surface water and sediment locations were not sampled (locations 410 and 407) during the 1988 field investigations. Location 407 did not have water present at the time of sampling under high flow conditions. During low stream flow, locations 407, 408, 409 and 411 were not sampled due to the lack of surface water at these locations. Location 410 was not sampled at either flow condition due to active construction taking place at that location.

All surface water samples collected in 1989 were analyzed for pH, specific conductivity, total lead, sulfate, and chloride. In addition, the surface water sample from location WS-9 was also analyzed for supplemental metals (antimony, arsenic, cadmium, copper, selenium, tin, and zinc). Surface water samples were collected at several locations as illustrated in Figure 6. Sample locations were spaced approximately every 250 feet along the West Stream and approximately every 800 feet along the East Stream.

Sediment samples during the 1988 field activities were collected using a hand trowel to obtain the top one inch of sediment at each sampling location (Figure 6). These samples were analyzed for total lead. In 1989, stream sediments were collected with a Lexan® lined 24-inch piston corer at the locations indicated on Figure 6. After collecting the sample, the liner was removed from the piston cover, capped with clean plastic caps, and put in a cooler with dry ice. Each frozen sample was labeled as to location and which end was the top of the core. All sediment samples were analyzed for total lead. At location WS-9, the sediment sample were also analyzed for supplemental metals (antimony, arsenic, cadmium, copper, selenium, tin, and zinc). Sediment samples only were collected at locations (ES-4, WS-10, WS-13, WS-14, and WS-15) due to the absence of surface water at these locations at the time of sampling.

2.04 Soil Investigation

A sampling grid was developed to locate surface soil sampling points. By utilizing a grid pattern, the areal distribution of substances can be quantified without sampling biases. A regular grid pattern also allows the use of interpolation techniques to identify concentrations of contaminants between sampling points.

Lead concentration in surface soils would be expected to be highest and most variable near the source (i.e. the Site). As the distance from the source increases, the lead concentration in the surface soil would be expected to decrease and less variation in the lead concentrations would also be observed. Therefore, the surface soil sampling grid consisted of a finer grid pattern on the Site and a progressively coarser pattern as the distance from the Site increases.

Two hundred foot triangles were utilized within the property lines of the facility. Outside of the facility boundaries, two sets of four hundred foot triangles were used, followed by a single set of eight hundred foot triangles. This provides for characterization of surface soil concentrations at distances from the facility boundaries of 1600 to 2000 feet, which represents distances of approximately 2000 to 2500 feet from the source. The off-site surface soil sampling locations are presented in Figure 6, while on-site locations are presented in Figure 7.

Each grid point sample was composed of four discrete sub-samples collected from around the grid point and composited. A three meter diameter circle was measured around the grid point and

samples were taken from the northernmost point on the circle, the southernmost point, the easternmost point and the westernmost point and then composited. When a three meter circle could not be utilized around the grid point, four discrete samples were collected along a line extending approximately twenty feet from the grid point and then composited. Composite samples were collected to represent strata of 0"-3", 3"-6", 6"-12", and 12"-18" below grade. Soil samples from the secure landfill cover were to a depth of 18 inches or to the clay layer, whichever was least. All surface soil samples were collected by hand-driven 3/4" Lexan® tubes. Every effort was made to avoid collecting soil samples that were less than twenty feet from painted surfaces and/or under or immediately adjacent to trees, shrubs and/or structures. Collection sites were also located as far as possible from vehicle activity such as streets, driveways, parking areas and automobile repair areas. Soil sampling methodology is detailed in the Site Operations Plan.

Soil samples from 0"-3" and 3"-6" below grade were analyzed for total lead. Approximately 20% of the soil samples were analyzed for supplemental metals consisting of antimony, arsenic, cadmium, copper, chromium, selenium, tin, and zinc. Approximately 50% of the samples to be tested for the supplemental metals were selected from on-site locations. The deeper samples (>6 inches) were analyzed if the 3"-6" strata had a total lead concentration (dry weight basis) of greater than 200 mg/kg.

During the second round of sampling in 1989, two off-site and five on-site sample locations were sampled: 44 and 44A (off-site); and 211, 213, 217, 218, and 220 (on-site). Composite samples were collected of representative strata at 12"-18", 18"-24", and at most, 30" below grade to delineate the vertical extent of lead in the soils. The soil was sampled in accordance with the approved Site Operations Plan (O'Brien & Gere, 1988).

Soil samples from areas near the railroad tracks where stormwater is occasionally ponded were collected in September of 1988. Each sampling location was a composite of four discrete subsamples taken at the compass cardinal points on a three meter diameter circle. These soils were collected with a steel hand trowel that was cleaned in accordance with the procedures outlined in the approved Site Operations Plan (O'Brien & Gere, 1988). These 0-2 inch soil samples were analyzed for total lead concentration on a dry weight basis.

2.05 Ground Water Investigations

During NL's ownership of the site, numerous wells were installed to evaluate hydrogeologic conditions and water quality; forty-one of those wells remained functional when the remedial investigation hydrogeologic studies of the site began in August 1988. The RI work items completed at the site include:

- A total of three monitoring wells were installed on site and five monitoring wells were installed off-site.
- Water elevations obtained in August, October, December 1988 and December 1989.
- Continuous ground water monitoring in October and November, 1988.

- Gamma Ray Logging
- Ground water sampling.

2.05.1 Well Installation

Well designations at the site are based on the history of ground water investigations. Numerical designations (i.e., 10, 11) represent 4-inch diameter monitoring wells. Three wells identified as AR, BR, and CR2 are 4-inch diameter monitoring wells. Alphabetic designations (i.e., MS, MD) represent 2-inch diameter piezometers which have also been used to obtain water samples. Well identification followed by a "R" mean that the original well was damaged, destroyed, and this well is now a replacement. Well identification followed by "R2" means this is the second replacement well. Previous studies concluded that the site stratigraphy resulted in an unconfined aquifer overlying two confined aquifers (Geraghty & Miller, 1983).

Monitoring wells 15 and 17 were installed to monitor the water table. Monitoring wells 7, 14 and 16 were installed with the objective of monitoring the unconfined aquifer immediately above the confining clay. Monitoring well 18 was installed to provide a southwest perimeter well screened at the same elevation as monitoring well 11. Monitoring wells 12 and 13 were installed beneath the first occurrence of a confining clay at each location.

Monitoring wells 7, 14, 15, 16, 17, and 18 were installed by advancing hollow stem augers into the unconfined aquifer. Each well is constructed of 0.010 inch continuous slot 4-inch schedule 40 PVC screen with 4-inch flush joint threaded PVC extended to the

surface. Monitoring well 7 includes ten feet of screen while monitoring wells 14, 15, 16, 17, and 18 were constructed with fifteen feet of well screen.

Monitoring well #15 terminates at an elevation of 10.68 feet below mean seal level (MSL) while monitoring well #17 is 11.69 feet below MSL. Monitoring well #7 was completed at an elevation of 36.34 feet below MSL. Well #14 terminates at 34.61 feet below MSL and wells 16 and 18 were completed at an elevation of 43.21 feet below MSL and 41.96 feet below MSL respectively.

Monitoring wells 12 and 13 were installed in a confined aquifer using Mud rotary techniques to install a steel casing one foot into the top of the first red-white-yellow clay encountered. The steel casing was grouted in place and the grout allowed to cure overnight to properly isolate the aquifer above the clay from the aquifer below the clay layer. The steel casing from monitoring well #12 was set at an elevation of 36.69 feet below MSL (49.5 feet below grade). The boring for well #12 was extended into the first confined aquifer using an 8-inch roller bit. Drilling mud was circulated to reduce well bore collapse. The screen was set at the top of a red and white clay which was encountered at an elevation of 62.19 feet below MSL (75 feet below grade). The steel casing for well #13 was set at an elevation of 42.41 below MSL (54-feet below grade). The boring for well #13 was then completed with hollow stem augers. Well #13 was set at an elevation of 98.41 feet below MSL. Both monitoring wells 12 and 13 are constructed with

20-feet of 4-inch schedule 40, 0.010 slot PVC well screen and schedule 40 PVC riser casing.

A short term (21 minutes) draw-down test was conducted to evaluate if the bore hole of well #12 was adequately sealed from the aquifer monitored by well #7. To test the seal, well #12 was pumped at a constant rate of 10-gallons per minute and pressure transducers were placed in well #12 and well #7 to record changes in water levels over the time of the test. A plot of the water elevation of well #7 during the drawdown phase of the test of well #12 is illustrated in Figure 9. The recovery data for the two wells are illustrated in Figure 10. The water level in well #7 remained constant, verifying that the bore hole of well #12 is sufficiently sealed to prevent direct hydraulic communication between the aquifer monitored by well #7 and the aquifer monitored by well #12 through the bore hole of well #12.

Drilling equipment was decontaminated with a high pressure steam cleaner prior to drilling each well. Wells installed at the site had a filter pack placed around the screened interval and topped by a bentonite pellet seal. The remainder of the annular space was grouted with a cement/bentonite grout which was installed using a tremie pipe. Each well extends approximately 2.5 feet above the ground and is finished with a locking protective outer casing and a cement apron. After the installation of each monitoring well was complete, the wells were developed by continuous low yield pumping. Detailed monitoring well specifications depicting the construction of the wells installed as

part of this Remedial Investigation (RI) can be reviewed in Appendix A. Bore logs describing material encountered during well installation are included as Appendix B for wells installed during this RI and are included in Exhibit B for wells previously installed at the site.

2.05.2 Continuous Ground Water Monitoring

Continuous ground water monitoring was conducted to evaluate causes of water table fluctuations reported by previous studies and to provide further information on the hydraulic connections between the various aquifers at the site.

Ground water elevation changes can occur as a result of both natural and anthropogenic phenomena, each theoretically resulting in a unique trend in water level elevation. For this site, natural phenomena include precipitation, tidal influence and barometric pressure changes. Anthropogenic events that may influence the aquifer(s) under the site includes pumping and the railroad crossing through the center of the site.

A typical water table response to precipitation results in a relatively smooth, bell-shaped response of the water table elevation. The initial response is a subtle rise in elevation as a result of direct infiltration. This is followed by a continued water level rise as more regional water recharges the ground water. A trend that may also be observed when evaluating continuous monitoring data is that of time lag. If the volume of water that is needed to cause a head fluctuation in a well is large relative to the rate of that which water enters the well and/or the aquifer

monitored by that well, a period of time will elapse prior to the event being represented in the water level readings obtained from that well. This affect is commonly observed in wells screened in low permeable functions or observed between wells which were screened in different aquifers that are separated by low permeable strata.

Tidal influences usually result in a water level response with a periodic character. A plot of water level measurements would be similar to a sine curve. The time corresponding to maximum and minimum amplitudes should propagate with time, as tidal periods occur at different times each day. Tidal curves for Oldmans Creek during each week of monitoring are included as Figures 11 and 12.

Changes in barometric pressures can cause fluctuations in water level elevation in a well. Plots of barometric pressure for the Philadelphia, PA area for each week are included as Figures 13 and 14. High pressure periods tend to decrease ground water elevations while a low pressure will increase water levels. Changes in water levels as a result of atmospheric pressure changes should correlate with barometric measurements.

The pumping of wells may impact site water levels. Water level response may be repetitive if pumping is periodic and should be correlatable to the pumping cycle.

Crossing through the facility area is an active rail line. The weight of a passing train may cause water levels in wells screened in confined aquifers to rapidly rise and fall. If a train

entered and remained in the area, the water level should slowly decline as equilibrium is reached.

An Enviro-Labs EL-200/System 17 Ground Water Monitoring System was used to conduct the monitoring program. Two groups of monitoring wells were identified: Group I to be monitored the first week of the program (October 20-25, 1988) and Group II the second week (November 9-16, 1988). Each group contained both water table and first confined wells. Group I wells consisted of Monitoring Wells 9R2, 10, 11, ID, KD, OD, PD, and BR. Group II consisted of Monitoring Wells 9R2, 10, 12, 7, 2R2, 4R, LD, and MD. To monitor water levels a pressure transducer was installed in each well in the group and the recorder was set to collect water levels at 15 minute time intervals. A graph of water level versus time was constructed for each well to evaluate trends in water levels with respect to time (hydrograph). Individual well plots are presented in Appendix C.

2.05.3 Gamma Ray Logging

Monitoring wells 3R, 10, 11R, 12, 13, 16, 18, CR2, JD, and OD were logged using a GR-81 Gamma-Ray Logging System with a 1.5 inch, brass housing, scintillation probe manufactured by W.G. Keck & Associates, Inc. The unit responds to the natural radioactivity in the form of gamma rays being generated by the sediments. The unit operates equally well in cased and uncased wells and records the total gamma ray count over a selected time interval at selected depths. The down-hole logging device was lowered to the base of the well with logging proceeding from the base of the well to the

surface. Gamma ray counts were recorded every foot or every three feet within the well with a range of 200 counts per minute and a time constant of 20 seconds.

Fine grained materials generally yield higher gamma ray counts than coarse grained material as a result of the fine grained materials generally containing more naturally occurring radioactive constituents. Therefore, the bore logs of the wells completed at the site can be verified with regard to the thickness of the sand and clay units beneath the site.

SECTION 3 - PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.01 Surface Features

A topographic survey was conducted of the site and immediate vicinity of the property line, by Albert A. Fralinger, Jr., PA on May 29, 1990. The survey is included as Exhibit E. An aerial photograph and other photographs are provided as Exhibit G. The property is approximately 1300 feet wide (east-west direction) and approximately 2100 feet long (north-south direction). There are three large and distinct features of the site as follows: Factory complex, railroad; and landfill. The railroad runs generally east-west across the site and divides the site into two sections. The property south of the railroad contains the factory complex and the property north of the railroad contains the landfill.

The southern portion of the property contains the factory complex and landfill access dirt road. The fenced factory complex contains an office building and other structures used for secondary lead smelting and related activities. Five fuel storage tanks, two aboveground and three underground are located on the eastern edge of the property. In the southwestern corner of the factory complex are two septic tanks that are covered with a mound of earth. The fenced factory complex contains hundreds of drums containing various materials that NSNJ had accepted for processing. In addition, surface piles of rotary kiln slag, drosses and other materials are located on paved areas of the factory complex. The structures at the manufacturing area are deteriorating as evidenced

by leaking roofs and damaged wall panels. Stormwater has collected within the manufacturing area due to the lack of maintenance activities at the plant. Stormwater has collected in the vicinity of the truck dump (Figure 2) in a drainage trench in the center of the manufacturing area, and the basement under the refining kettles.

The northern portion of the site contains the landfill which is approximately 700 feet long by 400 feet wide and extends approximately 30 feet above grade. An office trailer and diked above grade leachate holding tank are also located within the fenced area north of the railroad tracks. Surface drainage of this portion of the site is radial.

The site is within an industrial park. East of the site, there are two large industrial complexes and a farm field, as illustrated on the aerial photograph (Figure 6). Neighboring the property to the north are farm fields and approximately 1000 feet north of the landfill are several residences along U.S. Route 130. A wooded lot and an industrial facility border the property to the west. Across the street from the property to the south is a residence, a farm field, a small vehicle repair garage, and a small propane storage facility.

The factory complex receives its utilities from Pennsgrove-Pedricktown Road. The nearby Military Reservation and residences south and west of the property are on city water, while residences along US Route 130, north of the property, use potable well water. City water is provided by the Pennsgrove Water Supply Co. which has

its well field 5 to 7 miles southeast of the site and withdraws ground water from the first confined aquifer (telephone conversation with water company in August 1989).

3.02 Meteorology

Climatologic data for Salem County is collected by the New Jersey Department of Agriculture. The 1987 Annual Report states that Salem County receives an average of 42.81 inches of rainfall per year. The region experiences an average temperature of 55.2°F, with a monthly average low of 33°F occurring in January and monthly high of 77°F occurring in July. The wind rose for Philadelphia, PA airport (Figure 4), indicates that over 50% of the wind over 3 miles/hour is from the west (north northwest to south southwest).

3.03 Surface Water and Sediment

The West Stream is a marshy stream that flows in and amongst vegetation. The stream is very shallow (1-3 inches deep) and flow in this stream during the field investigations was minimal. Stagnant areas and dry portions were evident. Sediments in portions of the stream are very fluid composed of fine sands, silts and clays. Culverts beneath the railroad and landfill access road allow site runoff to enter the West Stream.

The East Stream has a distinct and easily identifiable flow path. A 1970 aerial photograph suggests that the current channel was constructed prior to construction of the secondary lead smelter. Sediments in this stream were generally sandy with some mud south of the railroad and marshy north of the railroad. The topographic survey (Exhibit E) demonstrates that stormwater runoff

from the factory complex does not enter the East Stream. A neighboring industrial facility has a NJPDES permitted discharge to the East Stream, which causes stream flow to substantially increase north of the railroad tracks.

3.04 Soil

The soils under the NSNJ, Inc./NL Site are characterized by a thin (1-2 inches) layer of top soil containing little plant material over a tannish-brown, sandy soil. In wooded areas, a thick humus layer is overlaying the soil. This humus layer is generally six to eight inches thick. The soil under the humus was a tannish to reddish brown, sandy soil. Soils on adjacent agricultural lands have twelve to fourteen inches of rich, blackish-brown topsoil with an underlying tannish-brown, sandy soil.

3.05 Geology and Hydrogeology

3.05.1 Regional Geology

The geology of southwestern New Jersey is composed of Quaternary and Cretaceous sediments which lie upon a basement of early Paleozoic deposits (Table 14). Information regarding the physical character of the Cretaceous sediments has been obtained predominantly from borings and well logs in Pennsylvania and New Jersey. Cretaceous sediments (Raritan and Magothy Formation) consist of beds of sand and gravel separated by low permeable clays. These beds dip from 40 to 80 feet per mile to the southeast toward the Atlantic Ocean. Quaternary deposits (Cape May Formation) consist of sand and gravel containing small amounts of

silt and clay which are distributed throughout the lower Delaware River Valley as terraces and flood plain deposits (Greenman, et al. 1961).

The Raritan Formation (Fm) is a lithostratigraphic formation which consists of alternating beds of nonmarine clay, sand and gravel (Greenman, et al. 1961). The Raritan Fm is divided into six lithostratigraphic members: Farrington Sand, Lower Clay, Sayreville Sand, Middle Clay, Old Bridge Sand, and Upper Clay (Table 14). Each of the "sand" members are excellent aquifers due to the high permeability sands and gravels contained within each. The "clay" members act chiefly as confining beds separating the "sand" members into these separate aquifers.

The Farrington sand member is the basal member of the Formation and overlays the precretaceous bedrock. This member is commonly composed of white, yellow, gray, and brown sand and gravel with some white clay. This member is the principal source of ground water in the Philadelphia, PA area.

The Lower Clay member is a continuous member of clayey material that overlays the Farrington sand. The Lower Clay member is composed of chiefly red clay that contains various amounts of gray, blue, white, and brown clay. Overlaying the Lower Clay is the Sayreville Sand member. The Sayreville Sand is composed of red-brown, white to gray sand and may contain a small amount of clay.

The Middle Clay member is composed of red and white clay with a tough massive texture. In the Philadelphia area, the Middle Clay generally has a thickness in excess of 20-feet. The thickness and the extremely low permeability of the clay makes this member an effective barrier to ground water movement between the Sayreville and Old Bridge Sand Member. The top and bottom of this member can be readily identified based on the distinct red and white coloration of the clay. The base of the member is marked by a bed of lignitic material. Overlaying the Middle Clay is the Old Bridge sand member.

The Old Bridge sand member, for the most part, occupies depressions in the underlying Middle Clay. The Old Bridge consists mainly of medium to coarse grained sand and contains minor amounts of fine to very fine sand. Beds of gravel are common at the base of the unit. The unit is typically light gray to yellowish brown in color and the sands are fairly well sorted with angular to subangular grains. The Old Bridge is not a distinct hydrologic unit over most of the area of its occurrence. It generally forms a continuous hydraulic unit with overlying deposits of Pleistocene sands and gravels.

The Upper Clay member is the uppermost member of the Raritan Formation. It consists of massive, red, white, yellow clays, and occasionally blue. The types of clay do not occur in any regular sequence or combination. The Upper Clay member, when present, separates the Old Bridge member from the overlying Pleistocene sands and gravels.

The Magothy Formation overlies the Raritan Formation and is composed of white and buff-colored, medium to coarse grained sands with alternating beds of dark clay and is commonly lignitic. The Magothy is underlain by the Upper Clay member but where the Upper Clay member has been eroded it is underlain by the Old Bridge Sand. The Formation is not considered an important hydrologic unit because of its small areal extent.

Pleistocene deposits consisting mainly of sand, gravel and clay completely bury the Cretaceous Sediments. The Cape May Formation is the youngest of three formations that subdivide the Pleistocene deposits of New Jersey and Pennsylvania. These Pleistocene formations are differentiated on the basis of their topographic position. The Cape May Formation occurs chiefly along the Delaware River at an altitude of less than 30 feet above sea level. The Pensauken Formation generally occurs in regions with higher elevations and generally stands between 20 feet below to 120 feet above sea level. Along the Delaware River most of the Pleistocene deposits have been removed by erosion. Brown to gray sand and gravel composed of medium to coarse grained, angular to rounded sand grains of quartz and pebbles of sandstone, siltstone, and chert dominate the Pleistocene deposits. Recent and Pleistocene deposits reach a maximum thickness of approximately 30 feet along the Delaware River.

3.05.2 Site Geology

The geology discussed above is similar to the geology encountered during well installation at the site. Bore logs for

the site are included in Appendix B and Exhibit B. The gamma ray logs show very good correlation to the bore logs in relation to the sequence of sediments. The depth and thickness of the various sediment units also correlate well. A plot of the gamma ray values along with the corresponding bore log is presented in Appendix D. The bore logs indicate that from 20 to 40 feet of brown to gray, medium sand was encountered below the site. Based on the above discussion, the description of the material encountered and the proximity to the Delaware River, these sediments belong to the Cape May Formation. Underlying the Cape May Formation at the site are alternating beds of white to buff sands and red, white and yellow clays. The description of these clays are similar to the ones described for the Magothy Formation and the Raritan Formation.

3.05.3 Site Hydrogeology

Ground water hydrology of the NSNJ, Inc./NL Site is complicated by the site's coastal plain geology. In previous investigations an unconfined, first and second confined aquifers were defined (Geraghty & Miller, 1983). The unconfined aquifer was defined as being in the Cape May Fm. and having a thickness of approximately 25 feet. The first confined aquifer was defined as being below a clay confining bed in an upper sand unit of the Magothy-Raritan Fm. The second confined aquifer was in a lower sand unit of the Magothy-Raritan Fm., beneath the lower confining bed of the first confined aquifer. In order to better define the relationships between the aquifers of the site, continuous monitoring was done on several wells around the site.

The hydrographs and detailed interpretation of the results is presented as Appendix C. Fluctuations in ground water elevations appear to be associated with rain events and ground water withdrawal on adjacent industrial properties. Tidal fluctuations were not evident. The unconfined aquifer wells respond very rapidly to direct infiltration from the surface. Deeper wells, 9R2, 12, and 10, demonstrate a delayed response to a rain event, suggesting limited hydraulic connection between the unconfined aquifer and the first confined aquifer.

Unconfined Aquifer

The unconfined aquifer directly beneath the Pedricktown facility occupies the Cape May and Magothy Formation which are composed of fine to medium-grained, brown and gray sands with interspersions of silty clay lenses. The saturated thickness extends from an elevation of approximately 7 feet above MSL to 15 feet below MSL (20 to 40 feet below grade). Ground water elevations obtained at the site (Table 15) resulted in the ground water contour maps included as Figures 20 and 21.

Ground water contours of the unconfined aquifer indicate that ground water flow is in a northwesterly direction. The ground water elevation obtained from well HS was not used to construct the water table contour map because well HS is screened predominantly in clay bed of the Cape May formation and terminates in the same portion of the unconfined aquifer as well HD. Ground water elevations for wells screened deeper in the unconfined aquifer indicate downward flow potential over much of the site. Ground

water flow in the deeper portions of the unconfined aquifer is variable due to the discontinuity of the various beds within the unconfined aquifer; however, the predominant flow direction is to the north and west of the site.

Ground water contours collected during the RI and those collected previously, indicate a ground water gradient of 0.0038 to 0.011 ft/ft with the predominate flow (the steepest gradient) in a northwest direction. Previous data collected at the site from a pump test (Geraghty & Miller, 1983) established the hydraulic conductivity of the unconfined aquifer to range from 1.87 to 45.52 ft/day. Geraghty & Miller (1983) calculated a linear flow velocity that ranges from 0.03 to 2.02 ft/day for the unconfined aquifer with an assumed porosity of 0.25.

Underlying the unconfined aquifer is the Upper Clay Member (Mem.) of the Raritan Formation. This Mem. is a red, white and yellow clay that separates the unconfined aquifer from the first confined aquifer. This Upper Clay Mem. is known to be discontinuous from the regional geology. Cross-sections of the NSNJ, Inc./NL Site confirm the discontinuous nature of the Upper Clay Mem. at the site.

First Confined Aquifer

The first confined aquifer is composed of fine to coarse grained light gray to brown sand of the Old Bridge Sand Mem. in the Raritan Fm. Gamma Ray logging confirms the bore logs which indicate that each of the wells considered to be screened in the first confined aquifer (wells 9R2, 10 and 12) are screened below

the Upper Clay Mem. There is a substantial ground water elevational difference between the wells that screen the unconfined aquifer and the first confined aquifer. This difference suggests a strong downward flow potential between the unconfined and the first confined aquifer.

Ground water contour maps of the first confined aquifer (Figures 22 and 23) indicate that the ground water of the first confined aquifer flows in a westerly direction. Ground water elevations in this aquifer are consistently below sea level. This low ground water elevation indicates that ground water pumping is influencing the ground water flow direction of the first confined aquifer.

Continuous monitoring data plots, as presented as appendix C, suggest that the first confined aquifer under the site is influenced by off-site pumping. A well search was conducted for O'Brien & Gere by the NJDEP to locate all permitted wells within two miles of the NSNJ, Inc./NL Site (Exhibit D). The well search indicated that there are numerous wells within the two mile radius of the site which screen the first confined aquifer. Therefore, the direction of ground water flow in the first confined aquifer will depend on which well(s) have the greatest influence on the first confined aquifer.

The recovery rate during the testing of well #12 (Section 2.05.1) is used to estimate this aquifer's transmissivity and hydraulic conductivity. A transmissivity value of 6,000 gallons per day per foot of draw down was calculated for the aquifer based

on the recovery in Well #12. Using an aquifer thickness of approximately twenty-three feet, as indicated by the drilling logs for Well #12, a hydraulic conductivity value of 35.3 feet per day (264 gpd/ft²) was calculated for the aquifer monitored by Well #12.

The base of the first confined aquifer is marked by a red and white massive clay of the Middle Clay Mem. of the Raritan Fm. Based on bore log data, the Middle Clay is approximately 30-feet thick under the site. The regional geology of this member suggests that the Middle Clay Mem. is a thick and extensive aquitard separating the first and second confined aquifer.

Second Confined Aquifer

The deepest wells used for the Remedial Investigation were 8R and 13 which terminate in the second confined aquifer. Wells 8R and 13 are screened in reddish-brown and white sands of the Sayreville Sand Mem. of the Raritan Fm. The water levels in these wells are considerably below sea level suggesting that this aquifer is significantly impacted by off site pumping. The cross-section D-D' (Figure 19) indicates that monitoring well 13 is hydraulically connected to well 8R. This is further supported by the similarity of their ground water elevation measurements (Table 15).

To evaluate flow direction in the second confined aquifer it was necessary to use data from neighboring properties (Exhibit D). The process water wells used by BF Goodrich are removing approximately 560,000 gallons per day from the confined aquifer. Based on boring logs and water elevations, it appears that water beneath the site in the second confined aquifer is within the cone

of influence of the industrial supply wells operated by BF Goodrich north and east of the site.

Hydrogeologic Summary

The local aquifer system can be separated into three aquifers (unconfined, first confined and second confined) on the basis of ground water elevations and lithology around the site. The cross-sections (Figures 16 through 19) illustrate that the site geology consists of thick and interfingering strata of clay and sand. The clay members function as aquitards. The discontinuity of the Upper Clay member provides the potential for the unconfined aquifer to communicate with the first confined aquifer as represented by the continuous monitoring data of wells 9R2, 10 and 12. The thickness of the Middle Clay Mem. observed at 13 and 8 (>20 feet thick), and its reported presence on adjacent industrial properties (Woodward Clyde, 1989) suggest that this aquitard extends across the site (Exhibit C) and separates the first confined from the second confined aquifer.

Ground water flow in the unconfined aquifer is predominantly in a northwest direction, however, discontinuous layers of sands and clays cause localized variations in flow direction. Ground water in the first confined aquifer appears to flow in a westerly direction. Ground water flow in the second confined aquifer appears to be in an easterly direction. This suggests that the industrial supply wells neighboring the site are controlling the second confined ground water flow under the site.

3.06 Demography and Land Use

The 1980 U.S. Census reported that total population of Oldmans Township, within which Pedricktown is located, at 1,847. Oldmans Township had an average of 3.12 people per household with a median age of 31.

The site is part of an area that is zoned for development as an industrial park and includes operations of the following major corporations: Airco; B.F. Goodrich; Brownin-Ferris Industries; and Exxon, Tomah Division. To the north of the industrial area, between the site and the Delaware River, is a military base and an Army Corps of Engineers Dredge Spoil area. The industrial park area is bordered by land that is a combination of open land, residential and agriculture as illustrated in the 1982 aerial photograph included as Figure 6. The residences are one or two story, single family homes. Agricultural lands produce a variety of crops, including tomatoes, corn, soybean, and asparagus.

SECTION 4 - NATURE AND EXTENT OF CONTAMINATION

This section presents an analysis of the data collected during the study and describes concentration levels found in the various environmental media in the study area. The spatial and temporal trends in concentration are discussed to provide assistance in evaluating the transport of the various contaminants.

4.01 Sources

Liquid Materials

The factory complex contained ponded stormwater on paved areas, trench drains, and basements. In addition, tanks and drums contained liquids within the fenced factory complex. The landfill includes four leachate sumps representing the two phases of the landfill and the primary and secondary liners as discussed in Section 1.03. Results of the laboratory analyses performed on the liquid materials from the factory complex are summarized on Table 2.

Three areas contain over 99% of the liquids in the factory complex. These areas are the ponded stormwater in the vicinity of the truck cut, the refining basements and the drainage trench in the center of the manufacturing area. These materials have identification numbers 122, 194, 196, 204 and 205 in Tables 1 and 2. Results from the analyses of these liquids demonstrate a mean lead concentration of 3.7 mg/l with a range from 1.62 mg/l to 6.95 mg/l. The geometric mean pH is 6.4 standard units (S.U.) with a range from 6.3 to 6.6 S.U. The mean Total Organic Carbon (TOC) was 7.4 mg/l.

Containerized liquids have a pH that ranges from 5.2 to 8.7. Total Organic Carbon ranges from <1 mg/l to 1720 mg/l. Total lead concentration ranges from 0.147 mg/l to 14.5 mg/l. Four samples were analyzed for Total Organic Halides (TOX) which range from <0.010 mg/l to 0.0325 mg/l. Four samples of containerized liquids were analyzed for gross alpha and gross beta radiologic parameters (Table 2). Gross alpha activities were less than detection limits. Gross beta activities ranged from below detection limits to 240 ± 80 pCi/l.

Solid Materials

The factory complex contains numerous solids associated with the secondary smelting of lead. Surface piles of rotary kiln slag and drosses are present. In addition, containers with lead-bearing feed materials, drosses, and wastes are located on-site. Analytical results of on-site solid materials are presented in Tables 3 and 4.

Table 3 shows that the on-site materials generally contain approximately 20% lead with a range from <1% to over 50%. The average lead concentration for the 39 samples tested was 24% (weight/weight) with a standard deviation of 17%. Only four samples had less than 5% lead by weight. Table 4 indicates that other metals such as arsenic, tin, antimony, cadmium, and zinc were present; however, lead typically represented over 90% of the metal present in the samples tested. Material identified as dross has a lead concentration which averaged 26% (w/w). Other elements present in varying amounts, up to 1% (w/w) were tin, zinc and/or

chromium. The color of the dross provided an indication of other metals present, for instance, yellow dross contained higher concentrations of tin.

Table 5 presents data from EP toxicity analyses performed on three composite slag samples and a duplicate. The results indicate that portions of the exposed slag generated by NSNJ are EP Toxic. Testing conducted by NL Industries on the rotary kiln slag during NL's operation (1980) demonstrated that the material was not EP Toxic (Exhibit H). NSNJ's operation was different from NL Industries, using different feed materials and operating conditions.

Since March of 1990, the USEPA has undertaken several response actions associated with the on-site solids and liquids (Exhibit K). Exhibit K indicates that the USEPA intends to remove the wastes "before the RI/FS is completed".

Leachate

Leachate samples were collected from each of the four leachate collection sumps< A primary, B primary, A secondary, B secondary. Results are presented in Table 6 with specific organic analytical results in Appendix K.

Results of the analysis performed on the leachate (Table 6) suggest that leachate from the A side primary sump of the landfill is a solution high in dissolved solids as evidenced by its tendency to crystallize at temperatures in the 50° to 60°F range. The high sodium concentration of 34,000 mg/l and pH 11.5 are consistent with the sodium carbonate used as part of the rotary kiln slag

production. The absence of lead in the leachate is likely due to the low solubility of lead carbonate (Stumm and Morgan, 1970). The presence of arsenic in the leachate at approximately 220 mg/l suggests that some waste within the fill contained arsenic which has been mobilized by the high pH leachate.

Results from the B side primary sump demonstrate much lower conductivity (13,500 μ mhos/cm), lower sodium (3,330 mg/l), and higher lead (0.254 mg/l). The lower pH may result in more mobility of lead. In addition, the arsenic concentration is much lower, suggesting that the waste containing the arsenic is not present in the B side or that the lower pH limits the mobility of arsenic.

Both phases of the landfill contain rotary kiln slag which is high in sodium and carbonates. Phase A of the landfill also contains process wastes from manufacturing activities which could explain the observed metal concentrations. The analytes examined in the leachate of Phase B occur at lower levels since hard rubber case material and soil excavated from the facility's grounds represent approximately 50% of the volume of Phase B (Figure 3).

The two secondary leachate collection sumps contain liquids. These liquids have a pH similar to that observed for the primary collection sumps. However, some parameters differ substantially between the primary and secondary leachate. Metal concentrations for aluminum, antimony, barium, chromium, and iron differed by an order of magnitude (10x) between the A primary and A secondary sumps. The B phase sumps also demonstrated order of magnitude (10x) differences in metal concentrations: aluminum, arsenic, cadmium, chromium, and lead.

The presence of liquids containing site-related substances in the secondary leachate collection systems is explained by landfill operating records. Landfill records demonstrate that during NSNJ operations of the landfill, primary leachate reached an elevation in the landfill above the primary sump access pipe and overflowed into the secondary sump access pipe. In addition, leachate elevations in the landfill are above the primary liner's anchor system (Exhibit A). Construction drawings presented as Exhibit L demonstrate that if leachate were to migrate through the clay side slopes above the membrane the leachate would enter the secondary leachate collection system. Observations made during the recent construction on the landfill support this mechanism. The construction activities described in Section 1.03 addressed this migration pattern.

4.02 Surface Water and Sediment

Surface Water

Analyses of the surface waters from the West Stream and East Stream (Table 8) during 1988 indicate that the total lead concentration of the water does not vary significantly between high and low flow conditions. Lead concentrations in the surface waters range from a low of 0.01 mg/l to a high of 3.0 mg/l. Results of the surface water analysis conducted on samples collected in 1989 can be reviewed in Table 9.

The East Stream surface water samples have a lead concentration that ranges from 0.010 mg/l to 0.101 mg/l. The lowest concentrations were collected downstream, locations north of the railroad. The East Stream conductivity, sulfate and chloride

concentrations changed substantially north of the railroad tracks as evidenced by the chloride value of <25 mg/l at ES-7 and 230 mg/l for ES-1. The pH in the East Stream ranged from 7.2 to 7.4 S.U.

The West Stream surface water samples have lead concentrations that range from 0.0488 mg/l to 2.2 mg/l. The highest value reported, 2.2 mg/l, was for the sample collected from the culvert south of Pedricktown Road, hydraulically upgradient of the site. The sample collected on the plant side of the road, WS 11, demonstrated a lead concentration of 0.190 mg/l. Other metals were detected at location WS-9 where the lead concentration of 1.27 mg/l was reported. Chloride concentrations were all less than the detection limit of 25 mg/l sulfate concentration varied along the West Stream from 9 mg/l south of the Pennsgrove-Pedricktown Road to 1200 mg/l at WS-7 located northwest of the factory complex. Examination of the ground water quality results, presented in Section 4.04, suggest this localized effect may be related to ground water recharge of the West Stream.

Sediment samples were collected from the East Stream, West Stream, and ditches which are connected to these stream. Sediment samples collect in 1988 and 1989 were analyzed for total lead.

East Stream sediment analyses during 1988 are presented in Table 8, while 1989 results are presented in Table 10. Surface sediment (0-3") concentrations in the East Stream ranged from 13.9 mg/kg to 638 mg/kg with a geometric mean of 110 mg/kg. The highest reported values for 1989 were in the tributary ditch along the

railroad tracks. Sediment lead concentrations generally decreased with depth with a geometric mean lead concentration in samples over 6 inches below grade equal to approximately 1 mg/kg.

Surface (0-3") sediment samples from the West Stream ranged in total lead concentrations from 171 mg/kg to 23,700 mg/kg with a geometric mean of approximately 1400 mg/kg. Sediment lead concentrations decreased with depth with the geometric mean concentration for samples over 12" below grade equal to approximately 15 mg/kg. The highest values reported were in areas where stormwater runoff from the factory complex could carry lead-bearing materials, such as rotary kiln generated by NSNJ, toward the West Stream. The surface sediment lead concentration furthest downstream of the site was 1350 mg/kg.

4.03 Soils

Results of soil analyses can be examined in Tables 12 and 13. Aerial distribution of the results of the on-site would samples and most of the off-site samples (0-3") can be examined on Figure 8. The on-site surface soils have concentrations of lead ranging from 19 mg/kg to a high of 12,700 mg/kg. The top of the landfill has the lowest lead concentration due to its construction date and off-site source of cover materials. Areas adjacent to the manufacturing area contain the highest concentrations. These high concentrations appear to be caused by runoff from plant areas that have exposed slag/dross/debris mounds in areas adjacent to where the samples were obtained. Off-site surface soil samples (Figure 6) had lead concentrations that ranged from 22.8 to 1770 mg/kg. Samples collected east of Porcupine Road (locations 48-50)

demonstrated a mean lead concentration of 30 mg/kg \pm 4 mg/kg. This value compares favorably with values from southwest of the site (25-32) which averaged 31 mg/kg 8 mg/kg.

With the exception of the anomalous value of 1770 mg/kg at location 44, a trend of decreasing soil leads, with distance from the site was evident. The average off-site surface soil lead concentration within 500 feet of the property boundary was approximately 210 mg/kg. The off-site soil lead concentration 3-6" below grade, ranged from 11.5 mg/kg to 382 mg/kg, exclusive of the anomalous location 44.

4.04 Ground Water

On-site monitoring and observation wells and the off-site private water supply wells that were sampled are listed in Table 16-1, 16-2 and 16-3. The ground water sampling procedures utilized in collecting samples from the wells are presented in the approved Site Operations Plan.

All on-site wells sampled, with the exception of wells installed during 1989, were analyzed for the following parameters:

Antimony	Lead	Sulfate
Arsenic	Selenium	Total Organic Carbon (TOC)
Cadmium	pH (field)	Total Organic Halogen (TOX)
Chromium	Conductivity (field)	Turbidity (field)
Copper	Chloride	

A few on-site wells were sampled and analyzed for inorganic priority pollutants as indicated on Table 17. All ground water samples from monitoring and observation wells with a turbidity greater than 5 NTU's (40 CFR 141.3) were field filtered through a 0.45 micron filter prior to heavy metals and radiological analysis.

Turbidity results were recorded and are presented with the analytical results (Table 16). Ground water samples from the private water supply wells along State Route No. 130 were not filtered.

Radiological analysis (Table 18-1 and 18-2) of ground water was conducted on all samples from the on-site and off-site wells. Wells included in the monitoring program were analyzed for gross alpha and gross beta particulate activity. Wells with gross beta activity or a high detection limit during the 1988 sampling were analyzed for total radium during the 1989 sampling. In addition, samples from wells RD, KS, KD, SD, and 2R2 were analyzed for radium isotopes, uranium isotopes, thorium isotopes, lead-210, and potassium-40 and other specific radionuclides as listed on Table 19, although there are no indications that radioactive materials were ever processed on-site.

Home Owner Supply Wells

Home owner well analyses (Table 16-3) demonstrated compliance with USEPA drinking water standards for metals and sulfate during both 1988 and 1989 sampling events. Slight differences in concentrations among wells are likely associated with the different aquifers being pumped. Independently, the USEPA sampled several potable wells along US Route 130 northwest of the site on August 17, 1988 and July 22, 1989 (Exhibit I). These results indicate that the private potable water wells along Route 130 have not been adversely affected by ground water from the NSNJ, Inc./NL Site and comply with USEPA and NJDEP MCLs.

Monitoring Wells - Unconfined Aquifer

Examination of the figures in Appendix E and F suggests that the unconfined aquifer has been impacted by activities in the manufacturing area as indicated by the concentration of metals in unconfined aquifer wells adjacent to the factory complex. Lead and cadmium were the most common elevated metals in ground water. The presence of cadmium and lead in the ground water is not unexpected given the open storage of rotary kiln slag in the factory complex. Runoff from these piles recharges the ground water system in the low areas on-site and adjacent to the paved areas.

The 1989 data (Table 16) demonstrate that only one of the nineteen wells (well MS) located north of the railroad tracks contained lead above 0.05 mg/l. The other wells around the landfill and the five hydraulically downgradient off-site wells demonstrated lead concentrations at or near the detection limit of 0.001 mg/l. Similar results were observed for cadmium with only two of the nineteen wells (wells 4R and MS) exceeding 0.01 mg/l.

The results of the radiologic analysis are included on Tables 18 and 19. Generally, the majority of the radio isotopes were found to be below method detection limits. However, the following isotopes were found to exist above detection limits in a few wells: gross alpha; gross beta; potassium-40; Radium 228; Thorium 228 and 232; and Uranium 234, 235 and 238. Higher concentrations of the various isotopes examined occur in wells in the vicinity of the plant site.

Examination of the literature (Exhibit F) suggests that the substances present may be naturally occurring radioisotopes. However, the site-wide variations in gross alpha and beta activity in the water table aquifer are not easily accounted for naturally. The limited data on the shallow water table wells suggests that the elevated gross alpha and beta activity is adjacent to the clay layers. Whether the variation can be attributed solely to the different types of clays present is unclear.

On-site unconfined aquifer wells demonstrate radium concentrations ranging from less than 0.8 pCi/l to 100 pCi/l. In some cases where radium exceeds 5 pCi/l the conductivity was elevated; however, in other areas with high conductivity (SS, SD, KD) the radium concentration was not elevated. Wells 2R2, KD and SD each have natural radiologic substances, uranium and thorium, present; however, each has low or non-detectable radium. Analyses for radionuclides do not indicate a radionuclide source at the site and there is no clear pattern of the radionuclide occurrence in the unconfined wells. The disequilibrium and the unusual distribution of these parameters suggests the need for further investigation of these radiologic parameters.

In August 1988, all wells on-site and off-site were analyzed for TOX and TOC. The highest concentration of TOX (1.750 mg/l) was found in well 11. The highest concentration of TOC (116 mg/l) was found in well 2R2. Supplemental volatile organic analyses were

conducted in 1989 to investigate the high TOC and TOX concentration. In August 1989, wells 2R2, MD, SD, and 11 were sampled and analyzed by Method 502 and 503. The results of these analyses are presented in Appendix G. Volatile organic compounds were not detected in wells 2R2 and MD, however, volatile compounds were detected in wells SD and 11. The compounds detected in well SD are commonly associated with fuel products (i.e., toluene and xylene), while chlorinated compounds were detected in well 11.

Three unconfined well locations yielded ground water samples which were substantially different from the remainder of the site. Because of the potential implications in the Feasibility Study each of these wells will be addressed separately.

Well 2R2, located adjacent to the landfill on its northern boundary contains water with elevated pH, sulfate and arsenic. Although the presence of sulfate is not unusual, the elevated pH, absence of other metals, and the presence of arsenic does make this well unusual. Leachate, currently being removed from the landfill leachate collection on this side of the landfill (A Phase), contains high arsenic concentrations. During 1988, a leachate seep was observed on the north edge of the landfill. NL completed a construction project to contain the leachate as described in Section 1.03. The hydraulically downgradient off-site monitoring

wells and homeowner wells along U.S. Route 130 did not contain detectable arsenic during 1988 or 1989 sampling.

Wells at location S identified as SD and SS screen the unconfined aquifer. Examination of the data generated since 1983 suggests that this well has been affected by the manufacturing processes which occurred approximately 200 feet from the well. In addition, surface recharge from slag piles and other storage material runoff would affect these wells. SD contains several metals such as beryllium, cadmium, chromium, copper, nickel, and zinc at concentrations, much higher than other wells. In addition, samples from this well demonstrated gross alpha and gross beta activities higher than any other well.

In response to the detection of chlorinated compounds in well 11, samples were collected from wells in the vicinity of well 11 in October 1989. Wells BR, 11, 11R, and 18 were sampled and analyzed by USEPA Method 601. Prior to sampling, it was suspected that well 11R had been vandalized. Well 11R was an on-site well that did not have a protective casing. A protective casing has been placed over the well. To see if the well had been tampered with, a sample was collected prior to purging the well (11R-BP) and after purging the well (11R-AP). results of the two samples were similar. The results of the analyses are included in Appendix G. The results confirm the presence of chlorinated compounds at well 11 and their absence at surrounding wells. Such an isolated occurrence of these compounds is unusual and at this time, a justifiable explanation for the localized occurrence of the volatile organic compounds is lacking. Supplemental studies are recommended in Section 7.

Although some changes in ground water quality were observed for individual on-site wells from August 1988 to August 1989, these changes were generally minor. Examination of 1983 data, presented in Exhibit B, suggests that the sulfate and filterable lead concentrations at wells near the manufacturing area have declined considerably. Wells surrounding the landfill and on the site perimeter have also demonstrated concentration reductions in 10 of 11 wells for sulfate and filterable lead.

Monitoring Wells - Confined Aquifer

Three wells are screened entirely in confined aquifers (wells 9R2, 12 and 13). Results of ground water analysis indicate that wells 9R2 and 12 in the first confined aquifer and 13 located in the second confined aquifer, have not been measurably affected by site activities. The confined wells all demonstrate non-detectable gross alpha activity. Gross beta activity ranged from non-detectable to 2.6 pCi/l. These values are similar to the private wells located along U.S. Route 130. These values demonstrate that the MCL's are presently being met in the confined aquifers used as water supply sources.

4.05 Air

In order to determine if the NSNJ/NL Site was a source for fugitive lead emissions the State of New Jersey evaluated the site by conducting field investigations, dispersion modeling, and stack test modeling. The State determined that since the plant's closure, the only source of fugitive emissions from the site was

the open slag storage piles. The State presented dispersion modeling data that showed no violations of the ambient lead standards from the slag pile emissions.

SECTION 5 - CONTAMINANT FATE AND TRANSPORT

This section presents a discussion on the migration and ultimate fate of various parameters in the different environmental media identified at the site.

5.01 Potential Routes of Migration

Migration of lead and other site substances could occur via three pathways: air, surface water, and/or groundwater. Prevailing winds could entrain soils and on-site materials, transporting them off-site. Precipitation on-site could route on-site materials off the paved areas and ultimately allow the migration of these substances to the West Stream via overland flow or drainage ditches. In addition, stormwater infiltration will recharge the ground water system. Ground water in the unconfined aquifer migrates predominantly to the northwest providing an additional transport route for on-site materials to migrate off-site. Each of these routes will be discussed in Section 5.03.

5.02 Contaminant Persistence

In previous sections of this report, discussions have described the concentrations of a few chemicals of particular interest in various media at the site. The chemicals at the site are of two types: inorganic and organic compounds. These two constituents behave differently and the factors that affect their persistence in the study area are different.

The principal metals present, lead and cadmium, are persistent and are not expected to be degraded by natural processes. Although arsenic is persistent, it can exist in various complexes which

affect mobility. Sulfate, chlorides and carbonates, the site-related anions are persistent ions. The solvents detected can be separated into the trace concentrations of aromatic petroleum components at well SD and the chlorinated volatile solvents found at well 11. The petroleum compounds detected; benzene, toluene, and xylene, are biodegradable at low concentrations. The observed concentrations, approximately 0.001 mg/l suggest that these materials will be naturally degraded in the near future. The chlorinated solvents detected at only well 1 included chlorinated ethanes and ethenes. These materials do naturally degrade (USEPA, 1989).

5.03 Contaminant Migration

The migration of the organic and inorganic compounds within the various media at the site and information relevant to the compounds migration is discussed below.

5.03.1 Air

The USEPA notice in Appendix J states that the only remaining source of fugitive dust emissions is from the open slag piles at the abandoned plant site. The notice also indicated that stack testing and air monitoring had been conducted to evaluate compliance. The State had performed dispersion modeling as part of the attainment evaluation and showed no predicted violations of the ambient lead standard. Based on the State's evaluation and the EPA's review, the site is in attainment for fugitive lead emissions and air dispersion does not appear to be a significant means of lead transport from the site.

To evaluate the migration of constituents of concern from the plant soils via fugitive emissions, a fugitive dust exposure evaluation was conducted (Appendix M). Ambient air concentrations of metals were calculated based on 95% upper confidence limit of all soil samples collected on-site. The results are used to quantify the risks associated with fugitive dust exposure as discussed in Section 6.

5.03.2 Surface Water

The on-site materials within the factory complex are not protected from precipitation. Stormwater runoff from the manufacturing area can flow through the culvert under the railroad and ultimately discharge to the West Stream. In addition, overland flow westward to the West Stream appears to have taken place. Transport of lead and other substances will be a soluble and particulate forms. Water samples within the drainage ditch tributary to the West Stream contain lead as do the sediments. Concentrations of lead in the stream were similar on three occasions, therefore, transport of lead and other metals downstream will occur when flow exists in the West Stream. As mentioned in Section 3.03, flow in the West Stream is intermittent.

Lead was detected in the water and sediments in the East Stream. The topographic survey indicates that the lead in this stream is not from site runoff. An anomolous high soil lead value at location 44 suggests better definition of soil leads in this area. Transport of lead downstream towards the Delaware River will occur, however, the rate is expected to be minimal due to the low

flow south of the railroad tracks. This is supported by the low lead concentrations measured north of the railroad tracks.

5.03.3 Ground Water

The ground water sampling and analyses demonstrate the presence of site-related substances such as heavy metals, and organic compounds in the unconfined aquifer on-site. On-site monitoring wells contain concentrations of cadmium and lead which exceed USEPA drinking water standards (Exhibit J). Organic compounds commonly associated with fuel products were detected in well SD. Chlorinated compounds were detected in well 11, but were absent in adjacent wells. Off-site water table monitoring wells located hydraulically downgradient to the northwest have not been impacted by site activities.

Various factors will attenuate or limit the migration of the organic and inorganic compounds within the aquifers at the site (USEPA, 1989). Organic compounds have a broad range of physical and chemical properties. Many organic compounds transform or degrade into other lesser organic compounds or they may combine with other organic and inorganic compounds. Various processes that would limit the migration of organic compounds from the site are as follows: hydrolysis; sorption onto subsurface soils; volatilization; and biodegradation.

The migration of inorganic compounds such as metal ions is also complex. The behavior of inorganic constituents is controlled by the speciation of the chemical. The factors that limit the migration of inorganic constituents are as follows: precipitation;

complexing with organic compounds or inorganic compounds such as sulfate and chloride; adsorption to the surface of subsurface materials; and ion-exchange with clays of humic matter.

The unconfined aquifer ground water flow velocity was averaged at 0.98 ft/day. In Section 4, discussion centered around the nature and extent of contamination around the site. The current limited extent of contamination relative to predicted ground water flow demonstrates that the migration of chemicals within the ground water is being impeded by the aforementioned factors.

SECTION 6 - RISK ASSESSMENT

6.01 Overview

This report presents a qualitative and quantitative exposure assessment of the potential human health hazards which may be associated with the National Smelting of New Jersey Site in Pedricktown, New Jersey ("the site").¹ This assessment was prepared for United States Environmental Protection Agency (U.S. EPA) review, and was conducted in accordance with U.S. EPA guidelines and procedures, as presented in the Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA 1989a).

In the opinion of O'Brien & Gere Engineers, Inc., the risks calculated and presented in this assessment are not a numerical presentation of actual risks to humans represented by the site. The values presented are a reflection of the methodology developed by the U.S. EPA. Inherent in this standard methodology for conducting risk assessments is the generation of risk values which are designed to overestimate actual site risks by utilizing standard assumptions and conventions. However, because they are generated by a "standardized" procedure, these risk values are useful as a basis for comparison between sites investigated, as well as to assist in identifying remedial objectives. The assessment addresses potential risks associated with chemicals

¹ A summary of the effects of lead on wildlife is presented in Appendix I. A complete environmental assessment will be prepared as an addendum to the Remedial Investigation Report.

detected in the ground water, soil, surface water, and surface water sediments on or originating from the site.

6.02 Scope of the Assessment

A risk assessment is a method which may be used to evaluate the potential health and environmental risks which may be associated with residual chemicals present at a site. There are a number of possible approaches to risk assessment: risks may be analyzed qualitatively to identify potential exposure scenarios, quantitatively to evaluate their magnitude and significance, or both. The risk assessment presented herein is a qualitative and quantitative assessment, conducted in accordance with guidelines and procedures of the U.S. EPA for evaluating human health risks related to hazardous waste sites, as described in the Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA 1989a).

This assessment focuses on the potential exposures to chemicals which may be present at the site, as detected in the air, soil, surface water, sediments, ground water, and surface wastes at, or believed to be originating from, the site. The assessment is based on analytical results from sampling conducted by O'Brien & Gere Engineers, Inc. in August 1988 through December 1989, as well as recent site visits by O'Brien & Gere Engineers, Inc.

This risk assessment does not address the worker employed to maintain the on-site landfill because OSHA regulates those activities. Access to the landfill is controlled by fencing; the fence is locked when the landfill is not staffed.

6.03 Organization of the Assessment

This risk assessment is divided into four main sections:

- 1) Identification of Chemicals of Potential Concern;
- 2) Exposure Assessment;
- 3) Toxicity Assessment; and
- 4) Risk Characterization.

6.04 Data Collection Considerations

Samples were collected from waste sources and from environmental media which potentially may be affected by the site. Sampling procedures and quality assurance/quality control (QA/QC) methods are presented in the Site Operations Plan (SOP) prepared by O'Brien & Gere Engineers, Inc. (OBG) in May 1988 (OBG 1988). The following discussion identifies the sampled media and preliminarily identifies potential human exposures:

- ▶ Slag, equipment residue, containerized solids, and containerized liquids were sampled to characterize waste sources. Wastes are currently contained in an area surrounded by a six-foot tall chain-link fence topped with barbed wire, and therefore currently are not accessible. However, if the fence were to deteriorate in the future, the wastes would be accessible to site trespassers.
- ▶ Since stormwater runoff from several sections of the plant area occasionally ponds in a portion of the site near the railroad tracks, surface water and sediment samples were collected from the area of occasional

ponding. This area is accessible to site trespassers (local children).

- ▶ Site stormwater runoff flows to the West Stream and site ground water likely releases to the West Stream. Therefore, surface water and sediment samples were collected from the West Stream. Due to its presence in the vicinity of the site, surface water and sediment samples were collected from the East Stream. Both the West and East streams flow to the Delaware River, which is accessible to local residents.
- ▶ Surface and subsurface soil samples were collected at on-site and off-site locations. On-site soil is accessible to site trespassers (local children), while off-site soil is accessible to local residents and workers.
- ▶ Since chemicals in the soil may leach into ground water, ground water samples were collected at on-site and off-site locations. Off-site ground water, potentially affected by the migration of site waste materials, is accessible to local residents utilizing ground water wells.

Background Samples

- ▶ Background surface water and sediment samples were collected from the West and East Streams.
- ▶ The complexity of the ground water flow beneath the site presents difficulties in determining background water quality for the site. Ground water data were obtained

from the Pennsgrove Water Supply Company (PWSC), which serves the site and its vicinity. The PWSC operates six ground water wells at locations approximately five miles upgradient from the site (PWSC 1990).

- Soil samples were collected from areas to the east of Porcupine Road. In addition, soil data was obtained from a NJDEP study in which 34 surface soil samples were obtained from rural areas across the State of New Jersey (NJDEP, 1990). To represent a worst case condition, the NJDEP values are presented in this assessment.

6.05 General Sampling Locations and Media

The site is an abandoned industrial facility which was operated as a secondary lead smelter. From 1971 to 1984, metal refining, fabricating, and associated activities were conducted at the site. During the operation of the facility, vast quantities of slag waste from processing (and other bulk, drummed, and/or containerized waste materials and raw materials) were allowed to accumulate in non-enclosed areas that were exposed to the elements. To determine if site-related chemicals has been released to soil, surface water, and ground water, the following general locations and environmental media were sampled:

- Representative samples of bulk and containerized materials at the plant were collected and analyzed to characterize waste sources at the site (see Section 3.02).
- Surface water and surface water sediment samples were

collected to evaluate the effect of stormwater runoff on off-site and on-site locations. Samples were collected from an area near the railroad tracks (which occasionally contains ponded water) and the West Stream adjacent to the site. Due to its presence in the vicinity of the site, samples were also collected from the East Stream (see Section 4.02).

- ▶ Soil samples were collected from numerous on-site and off-site locations to evaluate the horizontal and vertical distribution of metals in the soil (see Section 5.02).
- ▶ Ground water samples were collected from on-site and off-site monitoring wells, and downgradient private wells to identify the presence of a contaminant plume in local ground water (see Section 6.02).
- ▶ A plant-wide radiation monitoring survey was conducted to identify possible sources of radiation on the site.

6.06 Environmental Area

Surface Wastes

A complete description of the waste source sampling strategy is presented in Section 3.01. In summary, in October 1988, the following samples were collected: 1) three composite slag samples; 2) eight equipment residue samples; 3) 29 containerized solids samples; and 4) 21 containerized liquids. Bulk and containerized solids were analyzed for total lead and the following metals: antimony, arsenic, cadmium, chromium, copper, selenium, tin, and

zinc. Slag samples were analyzed for EP toxicity. Containerized liquids were analyzed for pH, total organic carbon, and total lead; four samples were also analyzed for total organic halides (TOX), and four samples were also analyzed for gross alpha and beta radiologic activity.

Soil

A complete description of the soil sampling strategy is presented in Section 5.02. In summary, in September 1988, composite soil samples were collected from 23 on-site and 49 off-site locations. Composite samples were collected from the 0"-3", 3"-6", 6"-12", and 12"-18" intervals.

Soil samples from the 0"-3" and 3"-6" intervals were analyzed for total lead by EPA Method 7420. In addition, approximately 10% of all soil samples were analyzed for supplemental metals (antimony, arsenic, cadmium, chromium, copper, selenium, tin, and zinc) by those methods listed in Table 12 of the SOP (OBG 1988).

In August 1989, composite soil samples were collected from six on-site and two off-site locations. Composite samples were collected from the 12"-18", 18"-24", and 24"-30" intervals. Samples were analyzed for total lead by EPA Method 7420.

Results of the soil analyses are presented in Tables 11-13. The chemicals and ranges which were detected in the soil samples are summarized in Table 20. Also presented are background soil concentrations obtained from the NJDEP. Two types of background soil concentrations are presented: geometric means (based on 34 rural area sampling locations across the State of New Jersey) and

concentrations for a sampling point (one of the 34) located in Pennsville.

Surface Water

A complete description of the surface water sampling strategy is presented in Section 4.02. In summary, in August and September 1988, surface water samples were collected from streams in the vicinity of the site (the East and West Streams). Five surface water samples were collected during low flow conditions, while six surface water samples were collected during high flow conditions. Samples were analyzed for pH and total lead by EPA Method 239.2.

In October 1989, 17 additional samples were collected from the streams. Samples were analyzed for total lead (by EPA Method 239.2), sulfate (by EPA Method 375.3), chloride (by EPA Method 325.2), pH, and conductivity. In addition, one sample from the West Stream was analyzed for supplemental metals (antimony, arsenic, cadmium, chromium, copper, selenium, tin, and zinc) by those methods listed in Table 6 of the SOP (OBG 1988).

Results of the surface water analyses are presented in Tables 8 and 9. As shown in Table 9, some metals (lead, cadmium, and chromium) were detected in the field blank. However, since the chemical concentrations detected in the surface water samples are more than five times greater than the concentrations detected in the field blank, site sample results were determined to be positive for these chemicals (EPA 1989a). The chemicals and concentration ranges which were detected in the surface water samples collected from the West and East Streams are summarized in Table 21. Also

presented are background concentrations, based on sample numbers 401 and WS-12 (for the West Stream) and ES-5 and ES-6 (for the East Stream).

In September and October 1988, surface water samples were collected from an area of the site which occasionally contains ponded water (near the railroad tracks). Samples were analyzed for pH and total lead by EPA Method 239.2.

In October 1989, two additional surface water samples were collected from the area containing ponded water. The samples were analyzed for total lead (by EPA Method 239.2), sulfate (by EPA Method 375.3), chloride (by EPA Method 325.2), pH, and conductivity.

Results of the ponded water analyses are presented in Tables 8 and 9. The chemicals and concentration ranges which were detected in the ponded water are summarized in Table 21. Since the ponded water originates on-site, background samples were not collected.

Surface Water Sediments

A complete description of the surface water sediment sampling strategy is presented in Section 4.02. In summary, in September 1988, sediment samples were collected from the streams in the vicinity of the site (the West and East Streams) and the area of the site which, occasionally, contains ponded water. Eleven sediment samples were collected from the ponded water area, while six samples were collected from the nearby streams. Samples were analyzed for total lead by EPA Method 7420.

In October 1989, sediment samples were collected from 24 locations in the streams and area of occasional ponding. Samples were collected from various depth intervals. All samples were analyzed for total lead by EPA Method 7420. In addition, samples from one location in the West Stream were analyzed for supplemental metals (antimony, arsenic, cadmium, chromium, copper, selenium, tin, and zinc) by those methods listed in Table 12 of the SOP (OBG 1988).

Results of the surface water sediment analyses are presented in Tables 7, 8, and 10. The chemicals and ranges which were detected in the sediments are summarized in Table 22. Background concentrations are based on sediment sample numbers 401, WS-12, and WS-13 (for the West Stream) and ES-5 and ES-6 (for the East Stream). Since the source of the ponded water is site run-off, background ponded area sediment samples were not collected.

Ground Water

A complete description of the ground water sampling strategy is presented in Section 6.02. The hydrogeology beneath the site is complicated by interbedded sands, silts and clays. Pumping of the Magothy-Raritan Formation results in a ground water elevation beneath the site of approximately 15 feet below mean sea level. This creates a substantial downward flow potential. Wells (44 total) located at depths ranging from the water table +6 feet elevation to -100 feet provide information on water quality at several depths across the site.

In August 1988, 28 ground water samples were collected from on-site and off-site monitoring wells. In addition, samples were collected from six private ground water wells situated downgradient of the site along Route 130. Although other downgradient ground water receptors may be present in the site vicinity, those receptors along Route 130 are situated closest to the site, and therefore, for purposes of this assessment, are the off-site ground water receptors of concern. Ground water samples with a turbidity of greater than 5 NTUs (40 CFR 141.3) were field filtered through a 0.45 micron filter prior to preservation for heavy metals and radiological analyses. Ground water samples from private wells were not filtered.

Ground water samples were analyzed for antimony, arsenic, cadmium, chromium, copper, lead, selenium, total organic carbon (TOC), total organic halogen (TOX), sulfate, chloride, pH, and conductivity. In addition, five monitoring well samples were analyzed for inorganic priority pollutants (the above metals plus silver, beryllium, mercury, nickel, thallium, zinc, and cyanide). Analytical methods are presented in Tables 6 and 7 of the SOP (OBG 1988). Monitoring well and private well samples were analyzed for gross alpha and gross beta particulate activity. In addition, ground water samples from two monitoring wells (2R2 and RD) were analyzed for specific radionuclides.

In August 1989, a second round of ground water sampling was conducted at all on-site and off-site wells previously sampled in August 1988. Samples from all wells were analyzed for cadmium,

lead, sulfate, pH, and conductivity by those analytical methods presented in Tables 6 and 7 of the SOP (OBG 1988). Samples from selected wells were analyzed for antimony, arsenic, chromium, copper, nickel, silver, and zinc by those analytical methods presented in Table 6 of the SOP (OBG 1988). In addition, samples from selected wells were analyzed for volatile organics by EPA Methods 502, 503, 601, and 602. Further, selected samples were analyzed for gross alpha and gross beta particulate activity, total radium, and specific radionuclides. The analytical methodology for radioactivity determination is presented in Exhibit C of the SOP (OBG 1988).

Also in August 1989, ground water samples were collected from nine private ground water wells situated downgradient of the site along Route 130. These samples were analyzed for cadmium, lead, and pH by those methods presented in Table 6 of the SOP (OBG 1988).

Analytical results of the ground water sampling events are presented in Tables 16 and 17, and Appendices E - G. As shown in Table 16 and 17, some metals were detected in the blanks. However, since the chemical concentrations detected in the ground water samples associated with these blanks are more than five times greater than the concentrations detected in the blanks, site sample results were determined to be positive for these chemicals (EPA 1989a).

Analytical results for the monitoring wells are summarized in Table 23, and analytical results for the private ground water wells are summarized in Table 24. Ground water data was also obtained

from the Pennsgrove Water Supply Company (PWSC), which supplies municipal water to the site and its vicinity (see Table 23). The PWSC obtains its water from six wells situated approximately five miles upgradient from the site (PWSC 1990).

6.07 Summary of Chemicals of Potential Concern

NSNJ operations at the site resulted in the accumulation of raw materials and wastes at the site. An inventory of these materials was conducted to quantify the amounts of these materials present at the facility and to identify their locations on the site. Bulk and containerized solids at the facility consist of: slag, equipment residue, baghouse dust, miscellaneous process waste, and raw materials. Results of containerized liquids analyses are presented in Table 2 (total lead concentrations range from 0.147 mg/l to 14.5 mg/l). Results of containerized solids analyses indicate that materials generally contain approximately 20% lead (with a range of <1% to >50%). Other metals (e.g., arsenic, tin, antimony, cadmium, and zinc) are present in the solids; however, lead typically represented over 90% of the metal present in the samples tested.

The list of potentially site-related chemicals is lengthy (see Tables 20-24). Carrying all chemicals through the quantitative risk assessment would likely distract from the dominant risks presented by the site. In order to reduce the number of chemicals used in the risk assessment, detected ground water and surface water concentrations were compared to New Jersey Drinking Water Standards. In addition, the number of matrices in which the

chemicals were detected was evaluated (see Table 25). As shown, two metals, chloride, and four volatile organics were excluded from the quantitative risk assessment, based on compliance with the drinking water standards and the lack of detection of these chemicals in matrices other than ground water or surface water.

As shown in Table 23, radioactivity was not detected above MCL concentration in the six potable supply wells tested. One on-site well (Well SD) demonstrated gross alpha and beta activity on the order of 500 pCi/l in spite of non-detectable values immediately above it in Well SS. Specific radioisotope analyses indicate the presence of Thorium and Uranium totaling approximately 400 to 500 pCi/l. An on-site source of radioactivity has not yet been identified. Portions of the State of New Jersey are known to exhibit elevated levels of radioactivity, however, the distribution is not easily explained as background. Therefore, radioactivity was not selected as a parameter for the quantitative risk assessment, pending development of additional data.

The chemicals of potential concern at the site are summarized in Table 26. As shown, chemicals of potential concern include metals, sulfate, and volatile organic compounds. These chemicals were used in the quantitative assessment to analyze the potential health risks to potential receptor populations.

For purposes of comparison, New Jersey Interim Soil Action Levels, Ground Water Standards, and Surface Water Quality Criteria are presented as Exhibit J. These standards and guidelines will be

considered during development of remedial response objectives, and will be discussed in more detail in the Feasibility Study.

6.08 Exposure Assessment

6.08.1 Characterization of Exposure Setting

The first step in evaluating exposure is to characterize the site with respect to its physical characteristics, as well as those of the human populations on and near the site. The output of this step is a qualitative evaluation of the site and surrounding populations with respect to those characteristics that influence exposure. Information gathered during this step supports the identification of exposure pathways in Section 7.08.2.

In summary, the site is an abandoned industrial facility situated in a rural area zoned for industrial park land use. The manufacturing area is surrounded by a six-foot tall chain link fence topped with barbed wire. The site is surrounded by industrial, commercial, agricultural, and residential land uses. A few residences in the vicinity of the site utilize private ground water wells.

Physical Setting

Climate - Climatologic data for the site vicinity is presented in Section 2.03: Climatology.

Meteorology - Meteorologic data for the site vicinity is presented in Section 2.03: Climatology.

Geologic Setting - Geological data for the site vicinity is presented in Section 6.01: Regional Geology.

Vegetation - The site supports sparse grasses (to approximately three feet in height). Along the western and northeastern boundaries of the site, wooded areas are present. The remaining portions of the site are covered with buildings, concrete, or asphalt.

Soil Type - The soil type for the site is presented in Section 5.01: Soil Description.

Ground Water Hydrology - Ground water hydrologic information is presented in Section 6.02: Hydrogeologic Field Investigations.

Location and Description of Surface Water - Locations and descriptions of on-site and nearby surface water bodies are presented in Section 4.01.

Location of Current Populations Relative to the Site

On-site - Current on-site populations consist of occasional trespassing adolescents (ages 10-12). Fencing of the RCRA landfill and manufacturing area prevents access to those portions of the site. Occasional trespassers can walk along the railroad tracks and access a portion of the site.

Off-site - Current off-site populations consist of the following: 1) residents 1500 feet to the north, 100 feet to the south, and 800 feet to the northwest of the site; 2) industrial workers 500 feet to the northeast of the site, 100 feet to the south, and 400 feet to the west; and 3) fishermen and swimmers in the Delaware River, approximately two miles to the northwest of the site.

Current Land Use

On-Site Receptors - The abandoned industrial site is currently situated in an area zoned as an industrial park. The site is currently abandoned, and is used only by occasional trespassers (local children). Currently, the maximum estimated exposure period for an on-site trespasser is one hour. According to the worker who maintains the on-site landfill, trespassing occurs on the unfenced portion of the site approximately once every three months, trespassers are aged 10-12, and trespassing events are of short duration (Ewing 1990).

In the future, in the absence of site remediation, it is possible that the fence surrounding the manufacturing area will deteriorate and facilitate trespassing in currently fenced portions of the site (i.e., within the manufacturing area). At that time, the maximum daily exposure period for an on-site trespasser would be 24 hours (if a vagrant were to live on the site). It is feasible that both adults and children would trespass on the site.

Off-Site Receptors - Off-site receptors in the vicinity of the site consist of residents, workers, and fishermen and swimmers in the Delaware River. It is expected that the maximum daily exposure period for an off-site resident is 24 hours, with eight hours of each day spent outdoors (during the summer). During the winter months, it is expected that the maximum time spent outdoors is four hours (for a child after school).

It is expected that the maximum daily exposure period for an off-site worker is 8 hours (an average work day), with 25 percent of each work day spent outdoors.

It is expected that the maximum daily exposure period for an off-site fisherman or swimmer in the Delaware River is eight hours (an entire day during the weekend) during the summer. Exposures are not expected to occur during the winter months due to the climate.

Future Land Use

The site is currently situated in an area zoned for industrial use. Since industrial facilities are present to the northeast, east, and south of the site, it is likely that the site land use designation will remain industrial. According to the definition of a baseline risk assessment, future site uses are to be analyzed based on no site remediation.

It is unreasonable to assume that industrial use would be implemented at the site in the absence of site remediation. Due to the deteriorating condition of the on-site buildings, the presence of large amounts of surface water within the manufacturing area, and the character and large quantity of the wastes, industrial operations could not commence on the site until new buildings were constructed and equipment was installed, and the surface water and wastes were removed from the site. Since these types of activities (i.e., waste removal) are not consistent with a "baseline" risk assessment,

it was concluded that, in the absence of site remediation, industrial use would not be implemented at the site.

In the absence of site remediation, it is also unreasonable to assume that residential or agricultural uses would be implemented at the site. This conclusion was based on the physical characteristics of the site (the presence of a closed RCRA landfill and the large amounts of wastes on the site). Residential or agricultural uses of the site could not be implemented without removing ponded surface water, wastes, buildings, and blacktopped areas. Since these types of activities are not consistent with a "baseline" risk assessment, it was concluded that, in the absence of site remediation, agricultural or residential land uses would not be implemented at the site. The U.S. EPA risk assessment guidance document (EPA 1989a) states " ... an assumption of future residential land use may not be justifiable if the probability that the site will support residential use in the future is exceedingly small." Further, "If the site is industrial and is located in a very rural area with a low population density and projected low growth, future residential use would probably be unlikely." (EPA 1989a, p. 6-7). As presented in Section 3.06 (Demography), the 1980 Census figure for Oldman's Township (in which Pedricktown is located) is 1,847. Also, as shown in Figure 1, the site is located in a very rural area.

Since, in the absence of site remediation, residential, industrial, or agricultural uses would not be implemented at the site, it was concluded that the current land use will not change in the future. Of the three types of potential future land uses evaluated (industrial, residential, and agricultural), industrial land use is the most probable (although still unlikely). For purposes of discussion and establishment of a "worst-case scenario", exposures to hypothetical future on-site industrial workers were quantified.

6.08.2 Exposure Pathways

An exposure pathway describes the course a chemical takes from the source to the exposed individual. An exposure pathway analysis links the sources, locations, and types of environmental releases with population locations and activity patterns to determine the significant pathways of human exposure.

An exposure pathway generally consists of four elements:

- 1) a source and mechanism of chemical release;
- 2) a retention or transport medium;
- 3) a point of potential human contact with the contaminated medium (referred to as the exposure point); and
- 4) an exposure route (e.g., ingestion) at the contact point.

Possible release sources, release mechanisms, and receiving media were identified for past, current, and future releases (see Table 27). As shown, it was determined that air, surface water, ground water, soil, sediment, and biota are/were potential

receiving media for release sources (wastes, soil, ground water, surface water, and sediment).

Potential exposure points were identified by determining if and where any of the potentially exposed populations (identified in Section 7.08.1) can contact the receiving media presented in Table 28. Any point of potential contact with a contaminated medium was considered to be a potential exposure point (see Table 29). In general, potential exposure points were identified where the concentration that could be encountered is the greatest.

After determining potential exposure points, potential exposure routes were identified based on the media contaminated and the anticipated activities at the exposure points. Potential exposure routes are presented in Table 29.

Following the identification of potential exposure points and potential exposure routes, complete exposure pathways were identified (see Table 29). A pathway was considered to be complete if there is:

- 1) a source or chemical release from a source;
- 2) an exposure point where contact can occur; and
- 3) an exposure route by which contact can occur.

If these conditions are not met, the pathway was determined to be incomplete. The following conclusions were made:

Air

On-Site - For current exposures, the air exposure pathway via inhalation was determined to be incomplete since the NJDEP has stated that the site has demonstrated

attainment for lead (see Appendix J), and surface waste piles have been sprayed with material to prevent fugitive emissions.

For future exposures under current and future land uses, the air exposure pathway via inhalation was determined to be complete since the material which was sprayed on the waste piles may eventually degrade and allow fugitive emissions to occur. At that time, on-site trespassers and on-site workers could inhale chemical residues in site air.

Off-Site - For current exposures, the air exposure pathway via inhalation was determined to be incomplete since the air pathway was determined to be incomplete at on-site locations. For future exposures under current and future land uses, the air exposure pathway was determined to be complete since the pathway was determined to be complete at on-site locations.

Surface Water

On-Site - For current and future exposures under current and future land uses, the surface water exposure pathway via incidental ingestion and dermal absorption in the on-site area of occasional ponding was determined to be complete. Trespassers occasionally gain access to the site and may contact ponded surface water near the railroad tracks. In the future, hypothetical on-site workers may contact ponded surface water.

Off-Site - For current and future exposures under current and future land uses, the surface water exposure pathway via incidental ingestion and dermal absorption in the West and East Streams was determined to be incomplete. Although chemicals of potential concern were detected in the streams, due to the swampy character of the drainage paths, surface water in the streams is inaccessible to receptors.

For current and future exposures under current and future land uses, the surface water exposure pathway via incidental ingestion, dermal absorption, and fish ingestion in the Delaware River was determined to be complete. Chemicals of potential concern may be transported to the Delaware River via the East or West Streams, and may be contacted by persons fishing, swimming, or boating in the River.

Ground Water

On-Site - For current and future exposures under current land uses, the ground water exposure pathway via ingestion, dermal absorption, and inhalation was determined to be incomplete at on-site locations. Ground water is not used at the site, and the site is served with municipal water by the Pennsgrove Water Supply Company. Water supply lines are present in Pedricktown and Porcupine Roads.

Off-Site - For current exposures, the ground water pathway via ingestion, dermal absorption, and inhalation was determined to be incomplete at off-site private wells. Based on analytical results for the ground water wells closest to the site (along Route 130), chemicals of potential concern have not migrated to downgradient private wells.

For future exposures under current and future land uses, the ground water exposure pathway via ingestion, dermal absorption, and inhalation was determined to be complete at off-site private wells. In the future, a complete pathway may exist if chemicals of potential concern in site ground water migrate downgradient to private wells.

Soil

On-Site - For current exposures, the soil exposure pathway via incidental ingestion and dermal absorption was determined to be complete at on-site locations outside of the fenced areas. Trespassers occasionally gain access to the site via the railroad tracks, and may contact contaminated surface soil (Ewing 1990). It is acknowledged that if trespassers were to gain access to areas within the fenced manufacturing area, soil exposures could occur in this area. This fence (six-feet tall chain link topped with barbed wire) appears to be a formidable barrier to trespass in this area.

For future exposures under current land uses, the soil exposure pathway via incidental ingestion and dermal absorption was determined to be complete at all on-site locations. In the future, it is possible that the fence surrounding the facility will deteriorate and facilitate access to all site surface soil.

Under hypothetical future industrial land use on-site, the soil exposure pathway via ingestion and dermal contact was determined to be complete. In the future, on-site workers could contact chemical residues in surface and subsurface soil during outdoor activities.

Off-Site - For current and future exposures under current and future land uses, the soil exposure pathway via incidental ingestion and dermal absorption was determined to be complete at off-site locations. Residents and workers on properties in the vicinity of the site may contact contaminated soil during outdoor activities.

Sediments

On-Site - For current and future exposures under current and future land uses, the sediment exposure pathway via incidental ingestion and dermal absorption was determined to be complete at the area of occasional ponding. Current and future site trespassers and hypothetical future site workers may contact contaminated

sediments in the ponded water area near the railroad tracks.

Off-Site - For current and future exposures under current and future land uses, the sediment exposure pathway via incidental ingestion and dermal absorption was determined to be incomplete in the West and East Streams. Due to the swampy character of the drainage paths along the streams, sediments are not readily accessible.

For current and future exposures under current and future land uses, the sediment exposure pathway via incidental ingestion and dermal absorption was determined to be incomplete in the Delaware River. Due to the depth of the River, sediments are inaccessible to potential receptors.

Wastes - For current exposures, the waste exposure pathway via direct contact was determined to be incomplete. The area containing wastes is completely encircled with a six-foot tall chain-link fence topped with barbed wire.

For future exposures under current and future land uses, the waste exposure pathway via direct contact was determined to be complete. In the future, it is possible that the fence surrounding the manufacturing area will deteriorate and facilitate trespassing in areas containing wastes.

Foodchain - For current and future conditions, the foodchain pathway via ingestion of game animals and crops was determined to be complete. Residents in the vicinity of the site may occasionally ingest game animals or crops (e.g., corn) on properties adjacent to the site.

Various complete exposure pathways were further evaluated in the exposure assessment (see Table 30). The following complete exposure pathways were not selected for quantification:

- ▶ Inhalation exposures of on-site and off-site air under current land uses were not quantified. In the future, the material which was sprayed on waste piles to hinder emissions may degrade and allow fugitive emissions to occur. However, potential future risks cannot be quantified at this time.
- ▶ Exposures in the Delaware River (water ingestion, fish ingestion, and dermal absorption) were not selected for quantification due to the large dilution factor which would be applied to West and East Stream concentrations entering the Delaware River. The West and East Streams flow rate in the vicinity of the site is so slow as to be almost stagnant. The Delaware River is situated approximately two miles to the northwest of the site, and is approximately one mile across and 50 feet deep. Therefore, a very large dilution factor would be applied

to West and East Stream concentrations entering the Delaware River.

- ▶ Incidental ingestion exposures to surface water in the ponded water area were not quantified. The magnitude of risk related to incidental ingestion exposures in the area of occasional water ponding is expected to be low since water in this area is shallow (0-12 inches, depending on rainfall). Dermal absorption exposures to ponded surface water are quantified, and are expected to be of much greater magnitude than incidental ingestion exposures.
- ▶ Dermal contact exposures to ground water for downgradient workers were not quantified. Since workers are not expected to shower or bathe at the workplace, it is likely that workers dermally contact ground water only during hand and face washing. Therefore, the magnitude of the risk related to dermal contact with ground water is expected to be low, and was not quantified.
- ▶ Future exposures to on-site soil were not quantified for on-site trespassers. It is assumed that in the future, the site fence may deteriorate and facilitate trespassing within the currently fenced manufacturing area. At that time, it is likely that most on-site exposures would occur in the manufacturing area, due to the relative attractiveness of the buildings, water, and wastes. The risks related to future soil exposures would be

insignificant in comparison to the risks related to waste exposures (exposures which are quantified).

- ▶ **Exposures to sediments in the area of occasional ponding** were not quantified. Sediments in this area were analyzed for lead only, and lead was detected at lower concentrations in these sediments than in other on-site soil. As a worst-case estimate, it was assumed that all on-site sediment/soil exposures occur in soil rather than sediments. Therefore, exposures to sediments in the area of occasional ponding (near the railroad tracks) were not quantified.
- ▶ **Exposures to wastes within the fenced manufacturing area** were not quantified. As described in Section 3.01, wastes contain a wide range of concentrations of inorganics. On-going waste removal actions are being conducted by the EPA, and documentation has not been provided regarding those wastes which have been removed from the site. Therefore, it was not possible to determine which wastes remain on the site, and exposures to wastes were not quantified.
- ▶ **Ingestion exposures to game animals** were not selected for quantification. Local residents may occasionally ingest game animals (e.g., deer, rabbits) residing on-site or in its vicinity. However, due to the short duration of hunting season, the limited amounts of game animals available, and the fact that occasional on-site ponded

water is not expected to be the primary drinking water source for game animals, the potential magnitude of risk is expected to be low and was not quantified.

- Ingestion exposures to crops were not selected for quantification. Although local residents may occasionally ingest local crops (e.g, corn, soybeans, and asparagus), the potential magnitude of risk is expected to be low based on reported soil concentrations and literature concerning lead uptake in plants, and therefore not a concern (see Appendix K).

6.08.3 Quantification of Exposure

The next step in the exposure assessment was to quantify the magnitude, frequency, and duration of exposure for the populations and exposure pathways selected for quantitative evaluation. First, exposure concentrations were estimated; then pathway-specific intakes were quantified. For this exposure assessment, intake variable values for a given pathway were selected so that the combination of all intake variables results in an estimate of the reasonable maximum exposure (RME) for that pathway.

The concentration terms in the intake equations are the average concentrations contacted at the exposure point over the exposure period. When estimating exposure concentrations, the objective was to provide a conservative estimate of this average concentration. Consistent with the approach specified in the guidance document (EPA 1989a), for each chemical of potential concern, the 95% upper confidence limit on the arithmetic mean

chemical concentration was used.² Using this approach, exposures will be overestimated; it is assumed that the calculated exposure concentration is present site-wide, and that exposures occur consistently at that concentration (an assumption which is inconsistent with existing data). The exposure concentrations for each matrix are calculated in Tables 31-36, and are summarized in Table 37. Exposure concentrations were calculated as follows:

Air - For future land use exposures to hypothetical on-site workers, air exposure concentrations were modeled. Ambient concentrations of chemicals of potential concern released in fugitive dust emissions through wind scour were calculated based on the 95% upper confidence limit on the arithmetic means of all soil samples collected on-site. Supporting documentation for the modeled air concentrations is presented in Appendix L. Modeled concentrations are listed in Table 31.

Ground Water - For future exposures to downgradient residents and workers, ground water concentrations were based on the 95% upper confidence limit on the arithmetic means of ground water samples collected from on-site and off-site monitoring wells during the period August, 1988 to August, 1989 (see Table 32). When a chemical was not detected in a sample, one-half the detection limit was used as the sample

² Two wells (2R2 and SD) were not used in estimating exposure concentrations. These wells contain relatively high concentrations of several metals which are generally absent or orders of magnitude lower in the other monitoring wells. Ground water exposure to concentrations in these wells are quantified separately.

concentration (except when one-half the detection limit is greater than the maximum detected concentration of that chemical). Since there is great variability in measured concentration values, the upper confidence limit on the average concentration is above the maximum detected value for some metals (nickel, selenium, and zinc). In these cases, the maximum detected value was used to estimate exposure concentrations (EPA 1989a). It should be noted that the calculated exposure concentrations are unrealistic since these concentrations were not detected site-wide (see Table 32), and chemicals in site ground water are likely to undergo adsorption, degradation, volatilization, and/or dilution prior to arriving at downgradient potable wells.

The unusual water quality of Wells 2R2 and SD is expected to represent current localized conditions, as opposed to future site-wide conditions. Metals detected in these wells are likely to be adsorbed to subsurface soils and clays, and therefore not experience significant off-site transport (see Appendix M). However, hypothetical future exposures to water quality of the type detected in Wells 2R2 and SD were quantified, based on the maximum concentrations detected in these wells (see Table 37).

Surface Water - For current and future land use exposures to ponded surface water near the railroad tracks, surface water exposure concentrations were derived from the 95% upper confidence limit on the arithmetic means of all surface water

samples collected from this area during the period September, 1988 to October, 1989. Since the upper confidence limit on the average lead concentration is above the maximum detected lead concentration, the maximum detected value was used to estimate the exposure concentration. Calculated exposure concentrations are presented in Table 33. It should be noted that the calculated exposure concentrations are unrealistic since these concentrations were not detected in all surface water samples.

Soil - For current and future off-site exposures to residents in the vicinity of the site, soil exposure concentrations were derived from the 95% upper confidence limit on the arithmetic means of all surface soil samples (0-1 foot interval) collected from residential areas in the vicinity of the site in September, 1988. Calculated exposure concentrations are presented in Table 34.

For current and future off-site exposures to industrial workers on properties in the vicinity of the site, soil exposure concentrations were derived from the 95% upper confidence limit on the arithmetic means of all surface soil samples (0-1 foot interval) collected from industrial areas in the vicinity of the site in September, 1988. Since there is great variability in measured concentration values, the upper confidence limit on the average concentration is above the maximum detected value for some metals (arsenic, chromium, copper, and zinc). In these cases, the maximum detected value

was used to estimate exposure concentrations. Calculated exposure concentrations are presented in Table 35.

For current land use soil exposures to on-site trespassers under current land use, soil exposure concentrations were derived from the 95% upper confidence limit on the arithmetic means of surface soil samples (0-3 inch interval) collected from accessible areas of the site, outside of the fenced portion of the facility. Since there is great variability in measured concentration values, the upper confidence limit on the average concentration is above the maximum detected value for lead. Therefore, the maximum detected value of lead was used to estimate exposure concentrations. Calculated exposure concentrations are presented in Table 36. It should be noted that the calculated exposure concentrations are unrealistic since these concentrations were not detected site-wide (see Table 36).

For future land use exposures to hypothetical on-site workers, soil exposure concentrations were derived from the 95% upper confidence limit on the arithmetic means of all soil samples collected on-site.³ When a chemical was not detected in a sample, one-half the detection limit was used as the sample concentration (except when one-half the detection limit is greater than the maximum detected concentration of that

³ Subsoil concentrations were used in the calculations since subsurface soil may be distributed at the site surface during industrial development of the site.

chemical). Calculated exposure concentrations are presented in Table 36. Since there is great variability in measured concentration values, the upper confidence limit on the average concentration is above the maximum detected value for arsenic, cadmium, and copper. In these cases, the maximum detected value was used to estimate the exposure concentration (EPA 1989a). It should be noted that the calculated exposure concentrations are unrealistic since these concentrations were not detected site-wide (see Table 36).

The exposure point concentration of each chemical of potential concern was used to calculate chemical intakes. Intakes were calculated for each receptor at each complete exposure route selected for quantification.

Assumptions - The following is a summary of the assumptions used in the health risk calculations. Most of the assumption values are default values specified in the U.S. EPA guidance document, designed to overestimate actual exposures. The term "Reasonable Maximum Exposure" is used in the guidance document in reference to the type of exposure evaluated through the use of these assumptions. However, it should be noted that the exposure evaluations are not "reasonable" due to the numerous upper-bound assumptions used in each exposure calculation (e.g., upper-bound exposure concentrations, upper-bound ingestion rate, and upper-

bound exposure durations may be used consecutively in calculations).

Air - Under the future scenario considered, on-site workers may inhale air containing fugitive dust emitted from contaminated soil. Intakes from inhalation of outdoor air were calculated (see Table 38). The following assumptions were used in the intake calculations:

- ▶ Air concentrations were modeled based on the 95% upper confidence limit on the current average soil concentration detected on-site (see Table 36 and Appendix L);
- ▶ An inhalation rate of 3 m³/hour (EPA 1989b, p. 3-8);
- ▶ An exposure time of 9 hours/day;
- ▶ An exposure frequency of 260 days/year;
- ▶ An exposure duration of 30 years, based on a 30-year term of employment at the site;
- ▶ An average body weight of 70 kg (EPA 1989a, p. 6-44);
- ▶ To evaluate non-carcinogenic health effects associated with long-term exposures, intakes were averaged over a period of 30 years; to estimate carcinogenic effects, intakes were averaged over a 70-year lifetime (EPA 1989a, p. 6-44).

Ground Water - In the future, under current and future land uses, chemicals of potential concern in site ground water may migrate downgradient to private wells and be contacted by

off-site residents and workers. Receptors may be exposed to chemicals of potential concern by ingestion of ground water used as drinking water, dermal contact with ground water, and inhalation of ground water during showering, cooking, or washing.

Intakes from ingestion of ground water used as drinking water (and beverages made using drinking water) were calculated for downgradient residents (children ages 10-12 and adults) and off-site industrial workers (see Table 39). The following assumptions were used in the intake calculations:

- ▶ Ground water concentrations were based on the 95% upper confidence limit on the current average ground water concentrations detected in monitoring wells (see Table 32). In addition, maximum concentrations detected in Wells 2R2 and SD were used to calculate exposures.
- ▶ Ingestion rates of 2 liters/day (child ages 10-12 and adult) (EPA 1989a, p. 6-35) and 1 liter/day (worker);
- ▶ Exposure frequencies of 365 days/year (residents) (EPA 1989a, p. 6-35) and 260 days/year (worker - 5 days per week for 52 weeks);
- ▶ Exposure durations of 30 years (adult, based on a reasonable worst-case length of residence at a single dwelling [EPA 1989a, p. 6-35]), three years (child ages 10-12), and 30 years (worker, based on a 30-year term of employment at a downgradient industry);

- ▶ Average body weights of 70 kilograms (kg) (adults and workers) (EPA 1989a, p. 6-35) and 36 kg (child ages 10-12) (EPA 1989b, Part I, p. 5-6);
- ▶ To evaluate non-carcinogenic health effects associated with long-term exposure, intakes were averaged over periods of 30 years (adult and worker) and three years (child ages 10-12). To estimate carcinogenic effects, intakes were averaged over a 70-year lifetime (EPA 1989a, p. 6-35).

Intakes from dermal contact with ground water during household use (showering and bathing) were calculated for downgradient residents (children ages 10-12 and adults) (see Table 40). The following assumptions were used in the intake calculations:

- ▶ Ground water concentrations were based on the 95% upper confidence limit on the current average ground water concentrations detected in monitoring wells (see Table 32). In addition, maximum concentrations detected in Wells 2R2 and SD were used to calculate exposures.
- ▶ Skin surface areas (total body) of 1.94 m² (adult) (EPA 1989a, p. 6-37) and 1.16 m² (child ages 10-12) (EPA 1989b, Part I, p. 4-9);
- ▶ Due to the lack of chemical-specific dermal permeability constants, the permeability constant for water was used (EPA 1988, p. 126);

- ▶ An exposure time of 0.25 hours (15 minutes) per day (EPA 1988, p. 127);
- ▶ An exposure frequency of 365 days/year (EPA 1988, p. 127);
- ▶ Exposure durations of 30 years (adult, based on a reasonable worst-case length of residence at a single dwelling [EPA 1989a, p. 6-38]) and three years (child ages 10-12);
- ▶ Average body weights of 70 kg (adult) (EPA 1989a, p. 6-38) and 36 kg (child ages 10-12) (EPA 1989b, Part I, p. 5-6);
- ▶ To evaluate non-carcinogenic health effects associated with long-term exposure, intakes were averaged over periods of 30 years (adult) and three years (child ages 10-12); to estimate carcinogenic effects, intakes were averaged over a 70-year lifetime (EPA 1989a, p. 6-38).

Inhalation exposures were quantified for off-site residents (adult and child) utilizing private ground water wells. Exposures were assumed to occur as a result of inhalation of contaminants transferred to the air from showers, baths, dishwashers, washing machines, and cooking. In general, exposures via inhalation are considered to be important only for volatile organic compounds (VOCs); inhalation exposures to nonvolatile organic and inorganic substances were assumed to be zero.

In this risk assessment, it was assumed that inhalation exposures from ground water use are equal to calculated exposures for the ground water ingestion pathway. The intakes associated with ingestion exposures (and, consequently, inhalation exposures) to VOCs in ground water are presented in Table 39.

Surface Water - Under the current and future land use scenarios considered, on-site trespassers (local children ages 10-12) and hypothetical on-site workers may contact chemicals of potential concern in ponded water near the railroad tracks via dermal absorption. Intake calculations are presented in Table 41. The following assumptions were used in the intake calculations:

- ▶ Surface water concentrations were based on the 95% upper confidence limit on the current average surface water concentrations detected in the area of occasional ponding (near the railroad tracks) (see Table 33);
- ▶ Skin surface areas of 0.312 m² (worker: arms and hands) (EPA 1989a, p. 6-41) and 0.204 m² (child ages 10-12: arms and hands) (EPA 1989b, Part I, pp. 4-9 and 4-12);
- ▶ Due to the lack of chemical-specific dermal permeability constants, the permeability constant for water was used (EPA 1988, p. 126);
- ▶ An exposure time of one-half hour per event;

- ▶ Exposure frequencies of four days/year (child trespasser: based on observations by the worker who maintains the landfill, who stated that trespassers are observed on the site at a frequency of once every three months [Ewing 1990]), and one day/week for on-site industrial workers;
- ▶ Exposure durations of 30 years (worker, based on a 30-year term of employment at the site) and three years (child ages 10-12);
- ▶ Average body weights of 70 kg (worker) (EPA 1989a, p. 6-38) and 36 kg (child ages 10-12) (EPA 1989b, Part I, p. 5-6);
- ▶ To evaluate non-carcinogenic health effects associated with long-term exposure, intakes were averaged over periods of 30 years (worker) and three years (child ages 10-12); to estimate carcinogenic effects, intakes were averaged over a 70-year lifetime (EPA 1989a, p. 6-37).

Soil - Under the current and future land use scenarios considered, off-site residents (adults during outdoor work and children during outdoor activities) and off-site industrial workers (during occasional outdoor job-related activities) may contact chemicals of potential concern in off-site soil. In addition, current on-site trespassers (children ages 10-12) may contact chemicals of potential concern in accessible on-site soil. Further, hypothetical on-site workers may contact

chemicals of potential concern in site soil. Soil may be contacted via incidental ingestion or dermal contact.

Intakes from incidental ingestion of chemicals in soil were calculated (see Table 42). Ingestion exposures were assumed to occur as a result of inadvertently ingesting soil/dust from hands during eating or smoking following outdoor work (e.g., gardening) (adult), outdoor activities (child), occasional outdoor job-related activities (worker), or site trespass (child ages 10-12). The following assumptions were used in the intake calculations:

- For off-site residents (adult and child) and industrial workers, soil exposure concentrations were based on the 95% upper confidence limit on the current average soil concentrations detected in residential or industrial surface soil (0-1 foot interval) in the vicinity of the site (see Tables 34-35). For a current child trespasser, soil exposure concentrations were based on the 95% upper confidence limit on the current average soil concentrations detected in accessible on-site surface soil (0-3 inch interval) (see Table 36). For hypothetical on-site workers, soil exposure concentrations were based on the 95% upper confidence limit on the current average soil concentration detected in site soil (surface and subsurface) (see Table 36).
- An ingestion rate of 100 milligrams (mg) soil/day (EPA 1989a, p. 6-40);

- ▶ As a conservative assumption, it was assumed that 100% of the soil ingested is contaminated;
- ▶ Exposure frequencies of 52 days/year (adult during outdoor work) (EPA 1989b, Part I, p. 2-54), 152 days/year (child during outdoor activities) (EPA 1989b, Part I, p. 2-52), four days/year (current child trespasser) (Ewing 1990), and 52 days/year (worker: one day/week for 52 weeks);
- ▶ Exposure durations of 30 years (adult, based on a reasonable worst-case length of residence at a single dwelling [EPA 1989a, p. 6-40]), three years (child ages 10-12), and 30 years (worker, based on a 30-year term of employment);
- ▶ Average body weights of 70 kg (adults and workers) (EPA 1989a, p. 6-40) and 36 kg (child ages 10-12) (EPA 1989b, Part I, p. 5-6);
- ▶ To evaluate non-carcinogenic health effects associated with long-term exposure, intakes were averaged over periods of 30 years (adult and worker) and three years (child ages 10-12). To estimate carcinogenic effects, intakes were averaged over a 70 year lifetime (EPA 1989a, p. 6-40).

Intakes from dermal contact with chemicals in soil were calculated (see Table 43). Intakes were calculated for off-site residents (adult and child ages 10-12), an on-site

trespassing child (ages 10-12), an off-site industrial worker, and hypothetical on-site workers. The following assumptions were used in the intake calculations:

- ▶ For off-site exposures, soil exposure concentrations were based on the 95% upper confidence limit on the current average soil concentrations detected in residential and industrial areas in the vicinity of the site (see Tables 34-35). For a child trespasser, soil exposure concentrations were based on the 95% upper confidence limit on the current average soil concentrations detected in accessible on-site surface soil (0-3 inch interval) (see Table 36). For hypothetical on-site workers, soil exposure concentrations were based on the 95% upper confidence limit on the current average soil concentration detected in on-site soil (surface and subsurface) (see Table 36);
- ▶ Skin surface areas of 0.312 m^2 (adult and worker: arms and hands) (EPA 1989a, p. 6-41) and 0.204 m^2 (child ages 10-12: arms and hands) (EPA 1989b, Part I, pp. 4-9 & 4-12);
- ▶ A soil to skin adherence factor of $0.51 \text{ mg soil/cm}^2 \text{ skin}$ (Hawley 1985);
- ▶ An absorption factor of one percent was used for all chemicals of potential concern in soil, with the exception of lead (Ryan 1987 - see Appendix N). An absorption factor of 0.06 percent was used for lead,

based on the median value of dermal absorption for lead acetate (Moore et al. 1980 - see Appendix O). The absorption factor of the more soluble lead acetate was used as a worst case assumption because absorption factors are not available for the relatively insoluble inorganic lead compounds such as lead sulfate and lead oxide present at the site.

- ▶ Exposure frequencies of 52 days/year (adult during outdoor work) (EPA 1989b, Part I, p. 2-54), 152 days/year (child during outdoor activities) (EPA 1989b, Part I, p. 2-52), four days/year (child trespasser), and 52 days/year (worker: one day/week for 52 weeks);
- ▶ Exposure durations of 30 years (adult, based on a reasonable worst-case length of residence at a single dwelling [EPA 1989a, p. 6-40]), three years (child ages 10-12), and 30 years (worker, based on a 30-year term of employment);
- ▶ Average body weights of 70 kg (adult and worker) (EPA 1989a, p. 6-40) and 36 kg (child ages 10-12) (EPA 1989b, Part I, p. 5-6);
- ▶ To evaluate non-carcinogenic health effects associated with long-term exposure, intakes were averaged over periods of 30 years (adults and workers) and three years (child ages 10-12). To estimate carcinogenic effects, intakes were averaged over a 70-year lifetime (EPA 1989a, p. 6-40).

6.08.4 Summary of Exposure Assessment

The reasonable maximum exposure (RME) at the site reflects the RME for a pathway as well as the RME across pathways. Populations of concern (residents, industrial workers, and trespassing children) may be exposed to chemicals from several exposure routes. The following exposure pathways were summed for the indicated receptors:

- ▶ **Off-Site Child Resident (Ages 10-12)** - ingestion, dermal absorption, and inhalation of ground water (future exposures); ingestion and dermal absorption of soil in residential areas (current and future exposures); ingestion and dermal absorption of site soil (current exposures); and dermal absorption of ponded surface water near the railroad tracks (current and future exposures) (see Table 44).
- ▶ **Off-Site Adult Resident** - ingestion, dermal absorption, and inhalation of ground water (future exposures); and ingestion and dermal absorption of soil in residential areas (current and future exposures) (see Table 45).
- ▶ **Off-Site Industrial Worker** - ingestion of ground water (future exposures); and ingestion and dermal absorption of soil in industrial areas (current and future exposures) (see Table 46).
- ▶ **On-Site Industrial Worker** - (hypothetical future) ingestion and dermal absorption of site soil; dermal

absorption of ponded surface water; and inhalation of site air (see Table 47).

Identification of Uncertainties

Based on the sources and degree of uncertainty associated with estimates of exposure, it is possible to evaluate whether the exposure estimates are the maximum exposures that can be reasonably expected to occur. Tabular summaries of the values used to estimate soil, ground water, surface water, and air exposures are presented in Tables 48-51. The tables includes the range of possible values for the parameters affecting intake, the midpoint of each range, and the values used to estimate exposures. In addition, a brief description of the selection rationale is included.

The major assumptions of the exposure assessment are summarized in Table 52. In addition, the degree to which each assumption is expected to affect the exposure calculations is presented. As shown, sources of uncertainty include the monitoring data, the exposure concentrations, and values of the intake variables used to calculate intake.

6.09 Toxicity Assessment

Toxicity assessment is accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether exposure to an agent can cause an increase in the incidence of a particular adverse health effect and whether the adverse health effect is likely to occur in

humans. Hazard identification involves characterizing the nature and strength of the evidence of causation.

The dose-response evaluation is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values (e.g., RfDs) are derived that can be used to estimate the incidence or potential for adverse effects as a function of human exposure to the agent.

6.09.1 Non-Carcinogenic Effects

Consistent with EPA methodology for conducting risk assessments, the following sources were consulted for toxicity information for non-carcinogenic effects: Integrated Risk Information System (IRIS) (EPA 1990a), Health Effects Assessment Summary Tables (HEAST) (EPA 1990b), and the U.S. EPA Environmental Criteria and Assessment Office (ECAO) (EPA 1990c) (see ECAO response in Appendix P).

Chronic RfDs were identified for evaluating potential non-carcinogenic effects associated with exposure periods between seven years and a lifetime (i.e., those to adult residents and workers). Subchronic RfDs were identified to evaluate exposure periods between two weeks and seven years (i.e., those to child residents and site trespassers). It should be noted that it was assumed that the chromium detected in the samples is Cr-VI, as opposed to Cr-III (which is much less toxic than Cr-VI). A summary of the toxicity values for potential non-carcinogenic effects is presented in

Tables 53-56. It should be noted that there are varying degrees of uncertainty associated with the toxicity values (e.g., values may be extrapolated from animal studies; extrapolated from chronic to subchronic exposures; uncertainty and modifying factors are applied to the values; and extrapolated outside the range of exposures studied).

6.09.2 Carcinogenic Effects

Consistent with EPA methodology, the following sources were consulted for toxicity information for carcinogenic effects: IRIS, HEAST, and the EPA Carcinogen Assessment Group (CAG) (EPA 1990d). Toxicity values (slope factors) were identified for evaluating potential carcinogenic effects associated with exposure to potential carcinogens having a U.S. EPA weight-of-evidence classification of A, B, or C. A summary of the toxicity values for potential carcinogenic effects is presented in Table 57. The slope factor is described by the U.S. EPA as an upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. It should be noted that there are varying degrees of uncertainty associated with the slope factors; slope factors for human health effects are often extrapolated from animal studies, and/or extrapolated from acute to chronic exposures. The slope factors are extrapolations outside of the range of exposures studied, and there is therefore no demonstrated basis supporting the probability

of cancer incidence at these levels. Therefore, for these reasons and others, calculated risks are not representative of actual site risks, but are theoretical approximations of the upper-bound lifetime probability of developing cancer as a result of exposure.

6.09.3 Unavailable Toxicity Values

EPA toxicity values (RfDs) for non-carcinogenic effects were not available in IRIS or HEAST for the following chemicals and pathways: antimony (inhalation), arsenic (inhalation), cadmium (inhalation), chromium (inhalation), copper (oral), 1,1-dichloroethene (inhalation), lead (oral and inhalation), sulfate (oral), tetrachloroethene (inhalation), vinyl chloride (oral and inhalation), and zinc (inhalation). Toxicity values are not presented for these chemicals (with the exception of lead).

The IRIS database, HEAST, and the EPA CAG were consulted in an endeavor to obtain an EPA-endorsed reference dose (RfD) value for lead. However, a value could not be obtained from these sources. The only values which the EPA endorses for comparison with detected lead concentrations in ground water and soil are the federal MCL for lead in drinking water (50 ppb; proposed to be 15 ppb), and OSWER Directive 9355.4-02 (which presents a soil cleanup range of 500-1000 ppm lead for residential land uses).

An oral acceptable daily intake for chronic exposures is available for lead in the Superfund Public Health Evaluation Manual (EPA 1986). This oral value (1.4 ug/kg/day) appears to be derived from the exposure rate of a 70-kg adult consuming two liters per day of water containing 50 ug/l of lead (the current Maximum

Contaminant Level [MCL]). In 1990, the EPA proposed revising the MCL for lead in drinking water from 50 ug/l at the point of use to 15 ug/l. In addition, the Center for Disease Control is considering a reduction in acceptable blood lead concentration from 25 ug/dl to 15 ug/dl. To reflect the proposed reduction in acceptable blood lead levels and to establish an additional margin of safety, an RfD of 0.84 ug/kg/day (60% of published value) will be used in this risk assessment.

EPA toxicity values (slope factors) for carcinogenic effects were not available for arsenic and lead via oral exposures. The proposed unit risk for arsenic in drinking water (obtained from IRIS) was used to calculate its slope factor (see Appendix Q). According to the EPA CAG, a slope factor is not available for lead, and the current database is not adequate to calculate a slope factor (EPA 1990d). Therefore, a slope factor was not calculated for lead.

6.09.4 Uncertainties

There are varying degrees of uncertainty associated with toxicity values used in the risk assessment. For EPA-verified RfDs obtained from IRIS, a statement of the confidence that the evaluators have in the RfD is presented. This is not reflective of the degree of confidence held by O'Brien & Gere Engineers, Inc. in these values. In addition, the Uncertainty Factor (UF) and Modifying Factor (MF) for each RfD is identified (see Tables 54-57). For slope factors, the EPA weight-of-evidence classification is presented in Table 58.

6.10 Risk Characterization

In this section of the risk assessment, the toxicity and exposure assessments are summarized and integrated into quantitative and qualitative expressions of risk. To characterize potential non-carcinogenic effects, comparisons are made between projected intakes of substances and toxicity values; to characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure are estimated from projected intakes and chemical-specific dose-response information.

6.10.1 Absorption Adjustments

To compare exposure estimates (calculated in Section 7.08.3) to toxicity values (presented in Section 7.09), both must be either expressed as absorbed doses or both expressed as intakes (administered doses). Except for the dermal route of exposure, the exposure estimates developed in Section 7.08.3 are in the form of intakes, with no adjustments made for absorption. The exposure estimates for dermal exposure are expressed as the amount of substance absorbed per kg body weight per day. Therefore, it was necessary to adjust toxicity values expressed as administered doses to absorbed doses for comparison with the dermal exposure estimates. In the absence of chemical-specific absorption information, a relatively conservative assumption of five percent oral absorption was used (EPA 1989a). Toxicity value adjustments are presented in Table 58.

Toxicity values for some chemicals of potential concern are expressed as absorbed rather than administered doses. For these chemicals (arsenic, cadmium, 1,1-dichloroethene, lead, and 1,1,1-trichloroethane), calculated exposure estimates initially expressed as administered doses were adjusted to absorbed doses. Exposure estimate adjustments are presented in Table 59.

6.10.2 Quantifying Risks

Current Exposures

An individual in the vicinity of the site may be exposed to a combination of substances through several pathways. Total current exposures to downgradient residents (child ages 10-12 and adult) and off-site workers were based on the following pathways:

- ▶ Off-Site Child (Ages 10-12) - ingestion and dermal absorption of soil at the residence and on-site (during site trespass), and dermal absorption of surface water in ponded water (during site trespass).
- ▶ Off-Site Adult - ingestion and dermal absorption of soil at the residence.
- ▶ Off-Site Worker - ingestion and dermal absorption of soil at the workplace.

Carcinogenic effects - For carcinogenic effects, risks were estimated as the incremental probability of an individual developing cancer over a lifetime as a result

of exposure to potential carcinogens⁴. The slope factors were used to convert estimated daily intakes averaged over a lifetime of exposure directly to incremental risks of an individual developing cancer.

The total calculated theoretical probability of the same individual developing cancer as a consequence of exposure to two or more carcinogens was calculated by summing the risk estimates for each potential/known carcinogen. The following total risks were calculated for current exposures: 9×10^{-7} (off-site child ages 10-12), 2×10^{-6} (off-site adult), and 1×10^{-6} (off-site worker) (see Tables 60-62). These risks are within the Superfund site remediation goal in the National Contingency Plan (NCP) (10^{-4} to 10^{-7}).

Non-Carcinogenic Effects - The potential for non-carcinogenic effects was evaluated by comparing exposure levels over a specified time period with reference doses derived for a similar exposure period. According to the methodology (U.S. EPA), this ratio of exposure to toxicity is called a hazard quotient. The hazard quotient assumes that there is a level of exposure below which it is unlikely for even sensitive populations to experience adverse health effects. If the exposure level

⁴ The numerical risk is not truly representative of probability, but is a product of the U.S. EPA risk assessment process. The risk value is not a means of predicting human health impacts, but is useful for comparing to remediation goals.

exceeds this threshold, there may be concern for potential noncancer effects.

To assess the overall potential for non-carcinogenic effects posed by more than one chemical, a hazard index (HI) approach was used. The HI is equal to the sum of the hazard quotients. When the total HI for an exposed group of individuals exceeds one, the approach utilized indicates that there may be concern for potential noncancer health effects.

For off-site adults and workers, HIs were calculated for chronic exposures, while for children ages 10-12, HIs were calculated for subchronic exposures (see Tables 63-65). The following HIs were calculated for current exposures: 0.40 (off-site child ages 10-12), 0.04 (off-site adult), and 0.05 (off-site worker). These HIs are within the Superfund site remediation goal (1.0).

Future Exposures Under Current and Future Land Uses

In the future, under current or future land uses, an individual in the vicinity of the site may be exposed to a combination of chemicals through several pathways. These exposure estimates address the addition of the ground water pathway, assuming that site ground water has been transported to an off-site potable well, and subsequently contacted. In addition, under the future site land use considered, hypothetical on-site workers may be exposed to a combination of chemicals through several pathways.

Three different types of ground water quality were identified during the evaluation of site ground water data: 1) site-wide ground water quality; 2) unusual ground water quality in Well 2R2 (exhibiting relatively high arsenic concentrations); and 3) unusual ground water quality in Well SD (exhibiting relatively high heavy metal concentrations). In quantifying potential future risks associated with the ground water pathway, it is more appropriate to use site-wide ground water quality, rather than localized ground water quality displayed by Wells 2R2 and SD. Localized contamination in Wells 2R2 and SD is expected to be adsorbed to soils and clay in the vicinity of these wells and not be transported site-wide or off-site (see Appendix M).

To provide an estimate of the risks associated with future exposures to site-wide ground water quality, as well as water quality in Wells 2R2 and SD, three types of future exposures were quantified. Total future exposures to downgradient residents and downgradient workers were based on the following pathways:

► Off-Site Child (Ages 10-12)

Type 1: Ingestion and dermal absorption of soil at the residence; dermal absorption of ponded surface water near the railroad tracks (during site trespass); and ingestion, dermal absorption, and inhalation of chemicals in site-wide ground water.

Type 2: Ingestion and dermal absorption of soil at the residence; dermal absorption of ponded surface water near the railroad tracks (during site trespass); and ingestion and dermal absorption of chemicals in Well 2R2.

Type 3: Ingestion and dermal absorption of soil at the residence; dermal absorption of ponded surface water near the railroad tracks (during site trespass); and ingestion and dermal absorption of chemicals in Well SD.

► Off-Site Adult

Type 1: Ingestion and dermal absorption of soil at the residence; and ingestion, dermal absorption, and inhalation of chemicals in site-wide ground water.

Type 2: Ingestion and dermal absorption of soil at the residence; and ingestion and dermal absorption of chemicals in Well 2R2.

Type 3: Ingestion and dermal absorption of soil at the residence; and ingestion and dermal absorption of chemicals in Well SD.

► Off-Site Worker

Type 1: Ingestion and dermal absorption of soil at the workplace; and ingestion of chemicals in site-wide ground water.

Type 2: Ingestion and dermal absorption of soil at the workplace; and ingestion of chemicals in Well 2R2.

Type 3: Ingestion and dermal absorption of soil at the workplace; and ingestion of chemicals in Well SD.

Total future exposures to hypothetical on-site industrial workers were based on the following pathways: ingestion and dermal absorption of site soil, dermal absorption of ponded water on-site, and inhalation of site air.

Type 1 - For Type 1 future exposures under current and future land uses, intakes associated with the ground water pathway were calculated based on ground water quality information from all monitoring wells except 2R2 and SD. This ground water quality data is expected to be more representative of site-wide conditions than data from Wells 2R2 and SD. Therefore, relative to the three future exposures analyzed (Types 1, 2, and 3), Type 1 is expected to be the most realistic future exposure scenario.

The following total risks⁵ were calculated for Type 1 future exposures: 7×10^{-4} (off-site child ages 10-12), 4×10^{-3} (off-site adult), and 9×10^{-4} (off-site worker) (see Tables 60-62). These risks are not within the Superfund site remediation goal in the NCP (10^{-4} to 10^{-7}).

For adults and industrial workers, HIs were calculated for chronic exposures, while for children ages 10-12, HIs were calculated for subchronic exposures (see

⁵ The numerical risk is not truly representative of probability, but is a product of the U.S. EPA risk assessment process. The risk value is not a means of predicting human health impacts, but is useful for comparing to remediation goals.

Tables 63-65). The following HIs were calculated for Type 1 future exposures: 102 (off-site child ages 10-12), 57 (off-site adult), and 20 (off-site worker). These HIs are not within the Superfund site remediation goal (1.0). Therefore, there may be concern for potential noncancer health effects.

Type 2 - For Type 2 future exposures, intakes associated with the ground water pathway were calculated based on ground water quality data for Well 2R2. Arsenic concentrations detected in Well 2R2 are above the State of New Jersey drinking water standard, while all other monitoring wells exhibited arsenic concentrations within the drinking water standard. Arsenic is expected to remain localized in the vicinity of Well 2R2 since arsenic is likely to adsorb onto subsurface soils and clays, and not be transported (to any significant degree) site-wide or off-site. However, for purposes of discussion, hypothetical future ground water exposures to ground water quality in Well 2R2 were calculated and summed with other future exposure pathways (e.g., soil ingestion).

The following total risks were calculated for Type 2 future exposures: 7×10^{-2} (off-site child ages 10-12), 3×10^{-1} (off-site adult), and 1×10^{-1} (off-site worker) (see

Tables 60-62). These risks are not within the Superfund site remediation goal in the NCP (10^{-4} to 10^{-7}).

For adults and industrial workers, HIs were calculated for chronic exposures, while for children ages 10-12, HIs were calculated for subchronic exposures (see Tables 63-65). The following HIs were calculated for Type 2 future exposures: 1002 (off-site child ages 10-12), 521 (off-site adult), and 185 (off-site worker). These HIs are not within the Superfund site remediation goal (1.0). Therefore, there may be concern for potential noncancer health effects.

Type 3 - For Type 3 future exposures, intakes associated with the ground water pathway were calculated based on ground water quality data for Well SD. Most heavy metals detected in this well were present at concentrations exceeding State of New Jersey drinking water standards. However, the metals are expected to remain localized in the vicinity of Well SD; the chemicals are likely to adsorb onto subsurface soils and clays, and not be transported (to any significant degree) site-wide or off-site. However, for purposes of discussion, hypothetical future ground water exposures to ground water quality in Well SD were calculated and summed with other future exposure pathways (e.g., soil ingestion).

The following total risks were calculated for Type 3 future exposures: 2×10^{-3} (off-site child ages 10-12), 1×10^{-2} (off-site adult), and 3×10^{-3} (off-site worker). (see Tables 60-62). These risks are not within the Superfund site remediation goal in the NCP (10^{-4} to 10^{-7}).

For adults and industrial workers, HIs were calculated for chronic exposures, while for children ages 10-12, HIs were calculated for subchronic exposures (see Tables 63-65). The following HIs were calculated for Type 3 future exposures: 39 (off-site child ages 10-12), 42 (off-site adult), and 14 (off-site worker). These HIs are not within the Superfund site remediation goal (1.0). Therefore, there may be concern for potential noncancer health effects.

On-Site Workers - A risk of 5×10^{-6} was calculated for hypothetical on-site industrial workers (see Table 66). This risk is within the Superfund site remediation goal in the NCP. A HI of 0.9 was calculated for hypothetical on-site workers. This HI is within the Superfund site remediation goal.

6.10.3 Uncertainties

The risk measures used in this risk assessment are not precise, deterministic estimates of risk, but conditional estimates controlled by a considerable number of consecutive upper-bound assumptions regarding exposure and toxicity. They are designed to

overestimate the true risk value, as opposed to present a precise, realistic estimate of it. This is done by convention, consistent with EPA protocols. There are several categories of uncertainties associated with risk assessments: selection of substances, toxicity values for each substance, and exposure assessment.

In the exposure assessment, several sources of uncertainty are the definition of the physical setting, parameter values, and tracking. Uncertainties related to these sources are discussed below.

Physical Setting - The initial characterization of the physical setting involves many professional judgments and assumptions. These include definition of current and future land uses, identification of potential exposure pathways, and selection of chemicals of potential concern. The following statements may be made regarding uncertainties:

- ▶ It was assumed that future off-site land uses will remain the same as present; there is a high probability that this assumption is true.
- ▶ Although it is likely that the site use will remain abandoned industrial in the absence of site remediation, for purposes of discussion, risks associated with future industrial site use were evaluated. In the absence of site remediation, there is a very low probability that the site will be used for industrial land use.

- ▶ There is a high probability that the complete exposure scenarios selected for quantification are actually occurring (or will occur).

Parameter Values - The selection of parameter values used in the risk calculations involves many professional judgments, assumptions, and default values dictated by the EPA methodology. These include calculation of exposure point concentrations, as well as selection of exposure frequencies, exposure durations, and intake rates. The following statements may be made regarding uncertainties associated with the parameter values:

- ▶ Numerous parameters are included in the calculations of human intake. The key parameters which influence intake are presented in Tables 48-51; the tables present the range of parameter values, the values used, and the rationale for the value selection.
- ▶ There is a very low probability that exposures to site contaminants (for the pathways identified as complete) will occur at the frequency, duration, and magnitude assumed in this assessment.
- ▶ There is a low probability that not quantifying several, but minor, complete exposure scenarios (e.g., ingestion of crops) may cause the final risk estimates to be underestimated.
- ▶ Those chemicals which were not included in the quantitative risk estimate due to missing information on

health effects or because of data limitations may represent a significant source of uncertainty in the final risk estimates.

- ▶ There is a high probability that the future ground water exposure risks are overestimated. Future ground water concentrations at off-site private ground water wells were assumed to be equal to current on-site ground water concentrations (a situation which is unlikely to occur).
- ▶ Three future exposure scenarios were quantified: Types 1, 2, and 3. Type 1 risk calculations are based on site-wide (rather than localized) ground water conditions. Elevated concentrations of chemicals in Wells 2R2 and SD are expected to largely remain localized in the areas of these wells (due to adsorption to subsurface soils and clay) and not be transported site-wide or off-site to any significant degree. There is a high probability that future ground water exposure risks for ground water users are better represented by Type 1 than by Type 2 or Type 3 risk calculations. It is acknowledged that the calculated health risks associated with the Type 1 scenario do not meet the goals of the NCP; if soil leaching to ground water continues (or increases) in the future, associated risks will remain outside of the goals of the NCP.
- ▶ There is a high probability that the future on-site air exposure risks are overestimated since atmospheric

concentrations were modeled using very conservative assumptions: e.g., assumptions that the site is flat, with no wind shield or obstructions, has 0% vegetative cover, and a continuous waste source.

Tracking - Uncertainties may be magnified or biased through the risk assessment process. Risk calculations utilize consecutive worst-case assumptions, while the probability of occurrence (of the series of worst-case parameters) is not considered. Therefore, risk estimates are overestimated.

Table 52 presents key assumptions used in the exposure assessment, and identifies the potential magnitude of these assumptions on the exposures. Uncertainty information for chemicals of potential concern is presented in Tables 53-57. These tables identify the weight-of-evidence for potential human carcinogens and the uncertainty adjustments for noncancer toxicity values.

6.10.4 Summary

A baseline risk assessment was performed using available analytical data. The risk and hazard index estimates were calculated to highlight potential sources of risk so that they may be considered for inclusion in the remedial process as remedial objectives. In summary, the following conclusions may be made:

- ▶ The major pathway driving future site risks is ground water. Specifically, for Type 1 exposures, current

concentrations of volatile organic compounds (1,1-dichloroethene and vinyl chloride) in ground water are driving the ground water risk. For Type 2 exposures, the current concentration of arsenic in Well 2R2 is driving the risk. For Type 3 exposures, the current concentration of beryllium in Well SD is driving the risk.

- ▶ The major factor reducing the certainty in the health risk calculations is the use of current on-site ground water concentrations to characterize future exposures at downgradient private wells. The metals detected in site ground water are expected to be adsorbed to subsurface soils and clays, and not be significantly transported site-wide or off-site (see Appendix M). It is expected that the use of on-site ground water data overestimates the potential future off-site risks related to the ground water pathway.
- ▶ The total cancer risks⁶ which were calculated for current exposures are 9×10^{-7} (off-site child ages 10-12), 2×10^{-6} (off-site adult), and 1×10^{-6} (off-site worker) (see Tables 60-62). These risks are within the Superfund site remediation goal in the NCP (10^{-4} to 10^{-7}). The total

⁶ The numerical risk is not truly representative of probability, but is a product of the U.S. EPA risk assessment process. The risk value is not a means of predicting human health impacts, but is useful for comparing to remediation goals.

noncancer HIs⁷ which were calculated for current exposures are 0.40 (off-site child ages 10-12), 0.04 (off-site adult), and 0.05 (off-site worker) (see Tables 63-65). These HIs are within the Superfund site remediation goal of 1.0.

- ▶ Three types of future scenarios were quantified for off-site residents and off-site workers. All three scenarios include exposures to ground water, soil, and surface water. It is expected that future exposures will most closely represent Type 1, as opposed to Types 2 or 3, since Types 2 and 3 are based on localized ground water conditions which are not likely to be transported site-wide or off-site. In Type 1, ground water exposures were based on site-wide ground water quality; in Type 2, ground water exposures were based on ground water quality in Well 2R2; in Type 3, ground water exposures were based on ground water quality in Well SD.
- ▶ The total cancer risks which were calculated for Type 1 potential future exposures (based on site-wide ground water quality) are 7×10^{-4} (off-site child ages 10-12), 4×10^{-3} (off-site adult), and 9×10^{-4} (off-site worker) (see Tables 60-62). These risks are not within the Superfund site remediation goal. The total noncancer HIs which

⁷ The hazardous index is not truly representative of the site risk, but is a product of the U.S. EPA risk assessment process. The hazard index value is not a means of predicting human health impacts, but is useful for comparing to remediation goals.

were calculated for Type 1 future exposures are 102 (off-site child ages 10-12), 57 (off-site adult), and 20 (off-site worker) (see Tables 63-65). These HIs are not within the Superfund site remediation goal.

- ▶ The total cancer risks which were calculated for Type 2 potential future exposures are 7×10^{-2} (off-site child ages 10-12), 3×10^{-1} (off-site adult), and 1×10^{-1} (off-site worker) (see Tables 60-62). These risks are not within the Superfund site remediation goal. The total noncancer HIs which were calculated for Type 2 future exposures are 1002 (off-site child ages 10-12), 521 (off-site adult), and 185 (off-site worker) (see Tables 63-65). These HIs are not within the Superfund site remediation goal.
- ▶ The total cancer risks which were calculated for Type 3 potential future exposures are 2×10^{-3} (off-site child ages 10-12), 1×10^{-2} (off-site adult), and 3×10^{-3} (off-site worker) (see Tables 60-62). These risks are not within the Superfund site remediation goal. The total noncancer HIs which were calculated for Type 3 future exposures are 39 (off-site child ages 10-12), 42 (off-site adult), and 14 (off-site worker) (see Tables 63-65). These HIs are not within the Superfund site remediation goal.
- ▶ A hypothetical future industrial scenario on-site (in the absence of site remediation) was quantified. The total cancer risk which was calculated for an on-site worker is 5×10^{-6} . This risk is within the Superfund site

remediation goal. The total noncancer HI which was calculated for an on-site worker is 0.9. This HI is within the Superfund site remediation goal.

- ▶ Key site-related contaminants were identified through environmental sampling. Those chemicals which were identified as chemicals of potential concern are present in various environmental media above background concentrations (see Tables 20-24).
- ▶ Various potential health effects are associated with exposures to high concentrations of the chemicals of potential concern. Potential carcinogenic health effects may include skin, lung, and liver cancer (see Table 57). Potential non-carcinogenic health effects may include liver and kidney effects (see Tables 53-56).
- ▶ Due to high dose to low dose extrapolation, extrapolation from animal to human data, and due to incomplete toxicity information for some chemicals of potential concern, there is a low to medium level of confidence in the quantitative toxicity information used to estimate risks. Tables 53-57 present the EPA confidence levels for toxicity values.
- ▶ With the exception of the ground water and air exposure pathways, there is a medium level of confidence in the exposure estimates for key exposure pathways. This is due to the fact that the exposure assumptions are designed to characterize "reasonable" maximum exposures.

- ▶ There is a low level of confidence in the risk estimates for the ground water exposure pathway. Current on-site ground water concentrations were used to characterize future exposures at downgradient private wells, and there is an extremely low likelihood that current ground water concentrations will be transported to downgradient wells.
- ▶ There is a low level of confidence in the future risk estimates for the air exposure pathway. For hypothetical on-site workers, on-site air concentrations were modeled using surface soil concentrations and very conservative assumptions (e.g., the site is flat with no wind shield or obstructions, has 0% vegetative cover, and the source is continuous).
- ▶ On-site wastes are currently contained in an area surrounded by a six-foot tall chain-link fence topped with barbed wire, and therefore currently are not accessible. However, if the fence were to deteriorate in the future, the wastes would be accessible to on-site receptors.

SECTION 7 - REMEDIAL INVESTIGATION SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.01 Summary

7.01.1 Nature and Extent of Contamination

The remedial investigation of the NSNJ, Inc./NL Site examined five areas as follows: waste materials at the facility; surface water and sediments at the site; surface and marsh soils; and ground water. This section presents a brief review of the results of the investigative activities conducted at the site.

Waste Materials

An inventory of bulk and containerized materials deposited by NSNJ, Inc./NL Site at the facility was conducted to quantify the amounts of these materials and to identify their locations. Leachate samples were collected from each of the on-site landfills sumps. Analyses were conducted on these samples to evaluate appropriate management approaches. The following conclusions have been developed.

- Approximately 7500 cubic yards of lead bearing materials are located on-site in battery bins and other uncontrolled areas.
- Approximately 1200 drums of lead bearing solid materials were identified during the inventory.
- The solid materials generally contain 20% lead with a low of <1% to a high of over 50%.
- Portions of the rotary kiln slag are EP Toxic with an average total lead concentration of about 10%.
- In the paved manufacturing area, there is approximately 480,000 gallons of rain water in trenches, pits and low spots. This value varies considerably with weather conditions.

- Leachate quality from the Phase A primary sump is quite different from Phase B primary sumps, however, both leachates contained high dissolved solids. Differences are explained by materials disposed of in the two phases of the landfill.
- Leachate is present in the secondary sumps for both phases. Leachate pumping is not required to maintain the leachate elevation, suggesting no current flow to the secondary leachate collection system. Landfill operation under NSNJ provides an explanation for the presence of leachate in the secondary sumps.

Surface Water and Sediments

Surface water and sediment investigations examined the conditions present in the two unnamed tributaries to the Delaware River. Surface water samples were collected at approximately 30 locations. Sediment samples were collected from the same locations and depth profiles for total lead developed. In addition, three samples were analyzed for eight other metals.

- Surface water in the stream along the west edge of the property (West Stream) has been impacted by activities conducted at the site with lead concentrations ranging from 0.049 mg/l to 2.2 mg/l.
- Surface (0-3") sediment samples in the West Stream ranged in total lead concentration from 171 mg/kg to 23,700 mg/kg with a geometric mean of approximately 1400 mg/kg.
- Sediment lead concentrations decreased with depth, with the geometric mean lead concentration in samples over 12" below grade equal to approximately 15 mg/kg.
- The surface sediment lead concentration in the West Stream furthest downstream from the site was 1350 mg/kg.
- Surface water in the East Stream ranged in lead concentration from 0.01 mg/l to 0.101 mg/l with an average concentration of approximately 0.030 mg/l.
- Surface sediment concentrations in the East Stream ranged from 13.9 mg/kg to 628 mg/kg with a geometric mean of approximately 110 mg/kg.

- Sediment lead concentrations in the East Stream generally decreased with depth, with the geometric mean lead concentration in samples over 6" below grade equal to approximately 51 mg/kg.

Soils

Soil samples were collected on-site and off-site at multiple depths ranging from the surface 3-inches to 24-inches below grade at some locations. Samples were collected in a triangular grid pattern with samples collected as far as 2800-feet from the property boundary.

- On-site surface soil samples ranged in concentration from 19 mg/kg to 12,700 mg/kg. The distribution could be explained by surface water transport patterns.
- Off-site surface soil lead concentrations generally decreased with distance from the site.
- Excluding a 1770 mg/kg anomalous value, the average off-site surface soil lead concentration was approximately 120 mg/kg. Samples at the twenty locations within 500-feet of the property boundary averaged approximately 210 mg/kg of total lead with the two highest concentration on industrial property north of the site in a wooded area.
- Off-site soil lead concentration 3-6" below grade range in concentration from 11.5 mg/kg to 382 mg/kg, exclusive of the anomalous location 44 described above.

Ground Water

A number of geologic field investigations were conducted at the site which included the following: well installation; draw-down and recovery test; continuous ground water monitoring; gamma ray logging; and ground water sampling and analysis. Eight wells were installed on and around the property. Ground water samples were collected from on-site monitoring wells and off-site private potable wells along US Route 130.

- Private supply wells located along U.S. Route 130 do not contain concentrations of analytes above USEPA drinking water MCL's.
- Three aquifers are defined and monitored by wells around the site as follows: unconfined, first confined, and second confined.
- Site activities in the manufacturing area of the site have impacted the unconfined aquifer in the vicinity of the manufacturing area. Cadmium, lead and sulfate are the most common contaminants found at elevated concentrations in the unconfined aquifer.
- Volatile organic compounds were detected at two unconfined aquifer wells. Analyses suggest that these substances are localized.
- Analysis for radionuclides did not indicate a radionuclide source at the site. There is no clear pattern of the radionuclide occurrence in the unconfined wells.
- Off-site monitoring wells within the unconfined aquifer north of the site do not contain concentrations of analytes above USEPA drinking water MCLs in the unconfined or first confined aquifer.
- Wells solely within the first confined aquifer (Wells 9R2 and 12) do not contain concentrations of analytes above USEPA drinking water MCL's.
- Samples collected from the second confined aquifer (Well 13) do not contain concentrations of analytes above USEPA drinking water MCL's.

7.01.2 Fate and Transport

Transport mechanisms functioning include air, surface water and ground water. Based on the information derived during the study, the following conclusions can be drawn:

- Migration of lead bearing materials off-site via wind is not a significant route.
- Stormwater runoff transports materials from the factor complex to adjacent soil, surface water bodies, and ground water.

- Based on the topographic survey, surface runoff from the manufacturing area drains to the West Stream.
- Based on the topographic survey and the distance to the stream east of the site (approximately 1000 feet), stormwater runoff from the fenced factory complex is not impacting this stream.
- Flow in the unconfined aquifer is predominantly to the northwest. Flow velocities are low as evidenced by off-site, hydraulically downgradient wells which do not indicate contaminant migration.
- Flow in the first confined aquifer appears to be controlled by aquifer pumping of the aquifer west of the site. The clay which separates the unconfined aquifer from the first confined aquifer may not be continuous creating a leaky confined aquifer. This could potentially allow site-related substances in the unconfined aquifer to migrate to the first confined aquifer.
- Flow in the second confined aquifer appears to be in an easterly direction toward industrial process water wells on adjacent industrial properties. The confining layer between the first and second confined aquifers appears to be quite substantial based on ground water elevations and the thickness of the clay strata. This suggests that if contaminants migrated into the first confined aquifer, they would be prevented from entering the second confined aquifer.

7.01.3 Risk Assessment

The risk assessment addressed potential human health risks associated with chemicals detected in the ground water, soil, surface water and sediment, and waste piles. Risks were calculated for current exposures and future risks using methodology developed by USEPA which is believed to overestimate actual site risks.

- Current risks to human health using this methodology are within the Superfund Site Remediation Goal in the National Contingency Plan.

- Risks to human health using this methodology calculated for potential future exposure under current and future land uses are not within the Superfund site remediation goals. The major exposure pathway representing potential unacceptable future site risks using this methodology is the ground water. The major factor reducing the certainty in the future risk calculations for off-site receptors is the use of current on-site ground water concentrations to characterize future exposures at off-site locations. It is expected that the use of this data highly overestimates the potential future risks related to the ground water pathway.

7.02 Data Limitations and Recommendations for Future Work

The following is a listing of recommendations for further investigation of the site.

- Stream sediment samples should be collected downstream of US Route 130 to delineate the downstream extent of lead in the stream sediments.
- Additional sampling of soils for lead in the vicinity of the 1770 mg/kg (sample 44) is suggested to define the aerial extent of this anomalous result.
- Well 10 is screened in the unconfined and the first confined aquifer. Well 10 should be sealed and a replacement well solely within the first confined aquifer should be installed at this location.
- First confined aquifer wells are recommended in the vicinity of the following unconfined wells: OS/PS and RS.
- A second confined aquifer well should be installed in the vicinity of wells 7 and 12.
- Sampling the new second confined well for volatile organic analysis by Methods 503.1 and 502.1, Radio-nuclides and Priority Pollutants, is suggested.
- Sampling all on-site first confined wells, and neighboring industrial supply wells in the first and second confined aquifers is suggested, with analysis for site-specific contaminants defined in the Site Operations Plan.
- Off-site unconfined monitoring wells north of the landfill should be sampled and analyzed for lead and arsenic.

- Further investigation of the radionuclide occurrence at the site is suggested to better define the source.
- An environmental assessment should be conducted to assess the extent the current and historical site activities have impacted the biota in the vicinity of the site. The assessment should include a delineation of wetlands, a wetlands assessment, and a floodplain assessment.

7.03 Preliminary Remedial Action Objectives

The following media have been affected by past activities at the NSNJ, Inc./NL Site:

- On-site Buildings and Other Structures
- Soils
- Stream Sediments
- Surface Water
- Ground Water

It is possible to identify preliminary response objectives for each of the above medias based on existing conditions and anticipated future usage. A brief discussion of each media follow with preliminary response objectives. Final response objectives will be developed during the Feasibility Study.

On-Site Buildings and Other Structures - The manufacturing complex includes several buildings, conveyors, kilns, and other structures. All of these structures have been affected by past manufacturing at the site. Exhibit G presents photographs in these areas. The manufacturing area is in an industrial park with several adjacent manufacturing operations. Therefore, it is assumed that future use of the property would be industrial or commercial.

The presence of 1200 drums of waste solids, 7500 cubic yards of bulk lead bearing materials, and approximately 500,000 gallons of contaminated water in the manufacturing area suggests that remedial action will be required prior to any future use of the manufacturing area. In addition, equipment specific to secondary lead smelting will have to be removed. Finally, buildings have been contaminated by lead bearing materials and thus would be unsuitable for occupancy without decontamination.

The preliminary response objectives for those structures remaining after remediation are:

- For porous and non-porous surfaces, lead dust concentration such that adverse impacts to human health would not occur in a commercial/industrial setting

Soils - Surface soil concentrations should be less than 1000 mg/kg in accordance with the USEPA interim guidance and anticipated land use of industrial/commercial.

Stream Sediments - Stream sediments should contain less than 250 mg/kg of lead.

Surface Water - Surface water should meet ambient water quality criteria for lead and other metals detected on-site.

Ground Water - USEPA MCLs for site-related substances should be met.

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Table 1
(continued)
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Waste Inventory

SAMPLED	STATE	NUMBER	MATERIAL TYPE	CONTAINER	VOLUME (cu yd)	MASS (lbs.)	DESCRIPTION
	L	046	Petroleum	Drum	0.27		no identifying marks; one drum 90% full.
	S	047	Dross	Drum	0.15		1517 one decomposed drum 50% full.
	S	048	Dross	Drum	0.30		3034 two drums 100% full.
	S	049	Iron	Pail	0.02		131 one pail of a black powder material 50% full.
	S	050	Iron	Bag			800 labeled: Magnifloat; magnetite, iron bearing sub., 8 partially broken bags.
	S	051	BHB	Drum	33.00		233626 lead oxide, 110 drums 100% full.
	S	052	Dross	Drum	0.75		7585 two drums 100% full, one drum 50% full.
	S	053	Dross	Drum	0.55		5563 three decomposed drums of 30%, 50% & 100% full.
X	S	054	Dross(yellow)	Drum	1.20		12136 four drums 100% full.
X	S	055	Dross(yellow)	Drum	0.60		6068 two drums 100% full.
	S	056	Dross(yellow)	Drum	0.30		3034 one drum 100% full.
	S	057	Dross(yellow)	Drum	0.30		3034 four drums 70-100% full.
	S	058	Dross(yellow)	Drum	0.81		8192 three drums 90% full.
	S	059	Dross	Drum	0.90		9102 three drums 100% full.
	S	060	BHB	Drum	19.50		138051 lead oxide, 65 drums 100% full.
	S	061	Dross(yellow)	Drum	0.15		1517 one drum 50% full.
X	S	062	Dross(yellow)	Drum	0.20		2022 unknown granular material; one drum 50% full.
	S	063	Dross	Slag pot	1.00		10114 one pot containing lead material 100% full.
	L	064-1	Water	Lead mold	0.50		843 mold containing water only.
	L	064-2	Water	Lead mold	0.45		759 mold containing 80% water only, on lead train.
	L	064-3	Water	Lead mold	0.45		759 mold containing 80% water only, on lead train.
	L	064-4	Water	Lead mold	0.45		759 mold containing 80% water only, on lead train.
	L	064-5	Water	Lead mold	0.45		759 mold containing 80% water only, on lead train.
	S	065	BHB	Drum	2.10		14868 seven drums of Bag house bags 80-100% full.
	S	066	Iron	Bag			2000 magnetite; one pallet of 25 unbroken bags.
	S	067	Slag	Drum	0.27		1911 one drum 90%.
X	L	068	Water	Tank	0.17		287 contained material to be determined. Cooling tower sump
	S	069	Slag	Lead mold	0.50		3540 unreacted slag in mold.
	L	070-01	Water	Slag pot	0.80		1348 water in pot.
	L	070-02	Water	Slag pot	0.80		1348 water in pot.
	L	070-02	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-03	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-03	Water	Slag pot	0.80		1348 water in pot.
	L	070-04	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-05	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-06	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-07	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-08	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-09	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-10	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-11	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-12	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-13	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-14	Water	Slag pot	0.80		1348 50% to 100% full
	L	070-15	Water	Slag pot	0.80		1348 50% to 100% full

Table 1
(continued)
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Waste Inventory

SAMPLED	STATE	NUMBER	MATERIAL TYPE	CONTAINER	VOLUME (cu yd)	MASS (lbs.)	DESCRIPTION
	L	070-16	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-17	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-18	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-19	Water	slag pot	0.80	1348	50% to 100% full
	L	070-20	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-21	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-22	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-23	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-24	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-25	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-26	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-27	Water	Slag pot	0.80	1348	50% to 100% full
	L	070-28	Water	Slag pot	0.80	1348	50% to 100% full
	S	071	Slag	Lead mold	0.50	3540	slag in mold 100% full.
	S	072	Lead	Lead mold	0.50	9524	100% full.
	S	073	Dross	Lead mold	0.25	2528	50% full.
	S	074	Slag	Drum	1.68	11894	17 drums 30% full, one lead pot 30% full.
	S	075	Slag	Slag pot	0.50	3540	100% full.
	L	076-01	Petroleum	Drum	0.05		one drum 15% full of a water/gear oil.
	L	076-02	Petroleum	Drum	0.05		one drum 15% full of a water/gear oil.
	L	076-02	Petroleum	Drum	0.30		four drums on edge lube oil.
	L	076-03	Petroleum	Drum	2.70		nine drums, approx. 100% full, lube oil.
X	L	077	Water	Drum	0.27	455	water on top of a soap composition, two drums 100% full.
	S	078	Coke	Drum	0.09	212	30% full.
	S	079	Red Phosphorus	Drum	0.92	2540	four drums 100% full; two drums 30% full.
	S	080	Sodium	Pail	0.18	294	six pails 100% full.
	S	081	Sodium Powder	Drum	0.30	343	one drum 100% full.
	S	082	Lead	Lead mold	7.50	142855	15 molds connected on lead train beneath rotary kiln.
	S	084	Lead Oxide	Tank			Cyclone 1 and Cyclone 2; empty
	L	085	Water	Pail			two buckets of rain water. empty
	S	086-01	Slag	Slag pot	1.00	7080	100% full
	S	086-02	Slag	Slag pot	1.00	7080	100% full
	S	086-03	Slag	Slag pot	1.00	7080	100% full
	S	086-04	Slag	Slag pot	1.00	7080	100% full
	S	086-05	Slag	Slag pot	1.00	7080	100% full
	S	086-06	Slag	Slag pot	1.00	7080	100% full
	S	086-07	Slag	Slag pot	1.00	7080	100% full
	S	086-08	Slag	Slag pot	1.00	7080	100% full
	S	086-09	Slag	Slag pot	1.00	7080	100% full
	S	086-10	Slag	Slag pot	1.00	7080	100% full
	S	086-11	Slag	Slag pot	1.00	7080	100% full
	S	086-12	Slag	Slag pot	1.00	7080	100% full
	S	086-13	Slag	Slag pot	1.00	7080	100% full
	S	086-14	Slag	Slag pot	1.00	7080	100% full
	S	086-15	Slag	Slag pot	1.00	7080	100% full
	S	086-16	Slag	Slag pot	1.00	7080	100% full

Table 1
(continued)
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Waste Inventory

SAMPLED	STATE	NUMBER	MATERIAL TYPE	CONTAINER	VOLUME (cu yd)	MASS (lbs.)	DESCRIPTION
	S	086-17	Slag	Slag pot	1.00	7080	100% full
	S	086-18	Slag	Slag pot	1.00	7080	100% full
	S	086-19	Slag	Slag pot	1.00	7080	100% full
	S	086-20	Slag	Slag pot	1.00	7080	100% full
	S	086-21	Slag	Slag pot	1.00	7080	100% full
	S	086-22	Slag	Slag pot	1.00	7080	100% full
	S	086-23	Slag	Slag pot	1.00	7080	100% full
	S	086-24	Slag	Slag pot	1.00	7080	100% full
	S	086-25	Slag	Slag pot	1.00	7080	100% full
	S	086-26	Slag	Slag pot	1.00	7080	100% full
	S	086-27	Slag	Slag pot	1.00	7080	100% full
	S	086-28	Slag	Slag pot	1.00	7080	100% full
	S	086-29	Slag	Slag pot	1.00	7080	100% full
X	S	087-01	Slag	Bulk	1110.00	7858314	"Slag Bldg. Bins".
	S	087-02	Slag	Bulk	0.18	1274	
X	S	087-03	Slag	Bulk	400.00	2831825	"Bin #1".
	S	087-04	Slag	Bulk	1.00	7080	in crusher bldg. on second floor
X	S	087-05	Slag	Bulk	3600.00	25486423	Coke and dross bins
	S	087-06	Slag	Bulk	1020.00	7221153	Battery bin # 5
	S	088	Slag	Bulk	7.40	52389	pile beneath the Kiln Burner Bldg.
	?	089	Slag	Pail	0.08	566	three 5 gal. pails 70%-100% full slag contaminated gravel
	G	090	Acetylene	Cylinder			approx. 80 CF, 7% full.
	G	091	Oxygen	Cylinder			approx. 80 CF, 7% full.
	G	092	Hydrogen	Cylinder			approx. 80 CF, 7% full.
	L	093	Petroleum	Drum	0.60		two drums of 20 WT. motor oil
	L	094	Petroleum	Drum	0.30		one drum of 30 WT. motor oil 100%.
	L	095	Petroleum	Drum	0.60		two drums of 220 ATF., Mobil
	L	096	Petroleum	Drum	0.30		hydraulic oil,
X	L	097-01	Water/Oil	Drum	0.09	152	one drum 30% full.
X	L	097-02	Water/Oil	Drum	1.50	2528	five drums 100% full.
X	L	097-03	Water/Oil	Pail	0.03	51	50% full
	S	098	Lead Bearing	Drum	0.30	2124	a decomposed drum containing floor sweeping material.
X	S	099	Molycorp	Pail	0.03		Note in sm. strg. bldg.: 50% full, Union 76 Molycorp.
	?	100	?	Pail	0.02		Note in sm. strg. bldg.: 50% full. Unable to confirm this location
X	S	101	Lead	Pail	0.09	1714	Note in sm. strg. bldg.: three pails 50%-100% full. Lead skimmings
	S	102	Lead Chloride	Pail	0.01	145	Note in sm. strg. bldg.: 100% full, labeled "corrosive".
	S	103	Petroleum Coke	Pail	0.12		Note in sm. strg. bldg.: two pails, one box both 100% full. Pemets #3
	S	104-1	Coke	Pail	0.01	1415	Note in sm. strg. bldg.: 10% full.
	S	104-2	Coke	Pail	0.03	4244	Note in sm. strg. bldg.: 100% full.
	S	105	Sodium Carbonate	Pail	0.02	11	Note in sm. strg. bldg.: 50% full, white in color.
	S	106	Florspar	Pail	0.09		Note in sm. strg. bldg.: three pails 100% full.
	S	107	Sodium Borate	Pail	0.03	78	Note in sm. strg. bldg.: two pails 100% full.
	S	108	Lime	Pail	0.03	71	one pail 100% full.
	S	109	Potassium Carbonate	Pail	0.03	103	Note in sm. strg. bldg.: one pail 100% full.
	S	110	Lead Oxide	Pail	0.03	22	Note in sm. strg. bldg.: one pail 100% full.
	S	111	Lead Oxide	Tank	30.00	148680	tank holding material from the Kiln. (Bag house)

Table 1
(continued)
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Waste Inventory

SAMPLED	STATE	NUMBER	MATERIAL TYPE	CONTAINER	VOLUME (cu yd)	MASS (lbs.)	DESCRIPTION
	S	112	Lead Oxide	Bulk			extending from the sweater furnace, vol. TBD. cyclone. empty
	S	113	Lead Oxide	Bulk	20.00	99120	extending from the sweater furnace, vol. TBD. bag house
	S	114	Soda Ash	Tank	220.00	373801	"Soda Ash Silo", LWC 23.4'.
	S	115	Iron	Bulk	0.50	3054	scrap iron, Iron hopper
	S	116	Coke	Tank	203.00	479050	"Coke Silo", LWC 27.3'.
X	S	117	Lead Oxide	Bulk	3.70	18336	lead oxide dust. Fuchs
X	S	118	Lead Oxide	Bulk	80.00	566365	area about feed conveyor way, lead bearing scrap, vol. 80 CY.
	S	119	Lead Oxide	Bulk	0.74	5239	spillage from bag house.
	S	120	BHB	Drum	0.42	2973	two drums 70% full, three boxes 100lbs. 90% full.
	S	121	Lime	Bulk	0.30	708	
X	L	122	Water	Trench	74.20	124210	trench drain parallel to Rotary Kiln.
	L	123	Water	Drum	0.03	51	10% full
	S	124	Lead Oxide	Drum	0.60	4248	two drums 100% full, material from Fuchs.
	S	125	Lead Bearing	Drum	1.92	13593	eight drums 70%-100% full.
X	S	126	Lead Bearing	Bulk	74.00	523888	lead feed material.
	S	127	Lead Bearing	Bulk	4.60	32566	lead feed material.
	S	128	Lead Bearing	Bulk	27.80	196812	Lead feed material
X	L	129	Water	Trench	49.50	82863	Thickener tank overflow cleanout ramp.
X	S	129	Lead Oxide	Trench	12.00	59472	Thickner tank over flow clean-out ramp
	S	130	Lead Bearing	Drum	0.30	2124	"Middlings" material, decomposed drum, 100% full.
X	L	131	Water	Tank	0.60	1011	15 CF, liquid layer of CK 131.
	S	131	Lead Oxide	Tank	0.01	50	solid layer of CU 131. decasing
X	S	132	Lead Oxide	Tank	1.40	9911	37 CF, 100% full lead oxide.
X	S	133	Iron Oxide	Tank	1.70	10385	Magnifloat
X	L	134	Water	Tank	1.60	2678	42 CF, adjacent to Kaylay flow meter
X	S	135	Lead Oxide	Tank	8.10	57344	2200 CF, 10% full. Filter drum
X	S	136	Lead Oxide	Tank	2.40	16991	330 CF, 20% full. Spiral Classifier
	S	137	Lead Oxide	Bulk	6.00	42477	Spillings from pellitizer
X	S	138	Dross	Drum	3.00	30341	ten drums containing grid metal and drosses 50%-100% full.
	S	139	Dross	Drum	0.20		four decomposed drums, 70% full.
	L	140	Petroleum	Drum	0.30		two drums 100% full, 80W-90 Mobil Lube.
	L	141	Petroleum	Drum	0.15		one drum 50% full, Exxon Chain Lube.
	L	142	Water	Tank			"Thickener Tank" - empty
	S	142	Lead Oxide	Tank	15.00	106193	"Thickener Tank" solid 1 ft. in thickness.
	S	143	Lead Oxide	Tank	11.63	57634	total depth 37.4 ft., depth to lead oxide 33.4 ft.
	S	144	Lead Bearing	Bulk	1.00	7080	lead bearing scrap.
	S	144-1	Lead Bearing	Drum	0.40	2832	lead bearing scrap, two drums 100% full.
	S	144-2	Lead Bearing	Drum	0.90	6372	3 drums 100% full.
	S	144-3	Lead Bearing	Drum	0.06	425	Note; TD right: one drum 20% full.
	S	145	Dross	Bulk	0.18	1820	One drum 60% full
	S	146	Iron	Bulk	1.00	8731	iron scrap.
	S	147-1	Lead Bearing	Drum	8.40	59468	approx. 28 drums 80%-100% full containing paper materials.
	S	147-2	Lead Bearing	Drum	0.30	2124	paper and tyvek material.
	S	147-3	Lead Bearing	Drum	8.10	57344	27 drums 100% full, paper materials.
	S	147-4	Lead Bearing	Drum	0.30	2124	Note; TD right: one drum 100% full, paper materials.
	S	148	Lead Bearing	Drum	0.24	1699	one drum 80% full, material is black in color (magnitite?).

Table 1
(continued)
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Waste Inventory

SAMPLED	STATE	NUMBER	MATERIAL TYPE	CONTAINER	VOLUME (cu yd)	MASS (lbs.)	DESCRIPTION
	S	149	Iron	Bulk	3.00	26194	coal material.
	S	149	Coke	Bulk	1.00	2360	in the area of "Bin #3", iron dross.
X	L	150	Water	Drum	1.50	2528	Assume 15% of 49 drums in top tier: liquid 70% full.
X	S	151	Lead Bearing	Drum	1.50	10619	Assume 15% of 49 drums in top tier: solid material 7%.
	S	152	Ceramic Glaze	Drum	1.50		Assume 15% of 49 drums in top tier: 100% full. Fired Glaze
	S	153	Paper	Drum	1.00	169	Assume 10% of 49 drums in top tier: paper cups, 70% full.
X	S	154	Lead Bearing	Drum	0.15	1062	7# solid material, 30%-70% full.
	S	155-1	BHB	Drum	2.20	15575	Assume 15% of 49 drums in top tier: 7# drums, BHB 100% full.
	S	155-2	BHB	Drum	0.60	4248	in the area of "Bin #2", two drums 100% full.
	S	156	Air Filters	Drum	1.80		Assume 15% of 49 drums in top tier: 80% full.
	S	157	Furnace Brick	Drum	1.76	7862	Assume 15% of 49 drums in top tier: 7# drums, 80% full.
	S	158	Jar Lids	Drum	0.30		one drum 100% full.
X	S	159	Dross	Drum	0.27	2731	one drum, 80%-100% full.
	S	160	Dross	Drum	0.20	2023	one drum, 70% full.
X	S	161	Dross	Drum	0.20	2023	one drum, 70% full.
	S	162	Cement	Drum	0.30	708	one drum, contained in plastic, 100% full.
X	S	163	Lead Bearing	Drum	2.85	20177	20 drums containing lead hard head material, 30%-50% full.
	S	164	Ash	Drum	0.16		one drum containing an ash-like material, 80% full.
	S	164-1	Lead Bearing	Drum	0.30	2124	one drum containing lead hard head material, 100% full.
	S	164-2	Lead Bearing	Drum	0.21	1487	Note; TD left: one drum containing lead hard head material, 70% full.
	S	164-3	Lead Bearing	Drum	1.89	13380	in the area of "Bin #2", nine drums, lead hard head material, 70% full.
	S	165	Sulfur	Drum	0.20	472	two drum 100% full, "Bee-Beed" material
	S	166	Dross	Drum	0.48	4855	two drums 80% full.
	S	167	Dross	Drum	0.24	2427	one drum 100% full.
X	L	168	Water	Tank	0.05	46	(4) Dross Hoppers: 3-empty, 1-10 gals.
	S	169	Lead Bearing	Drum	0.24	1699	Note; TD left: battery plates, one drum 80% full.
	S	170	Lead Bearing	Drum	78.00	552206	Note; TD left: "≈ 260 fiber drums w/ lead scrap & lead oxide, 100% full.
	S	170	Lead Bearing	Drum	0.15	1062	in the area of "Bin #2", one drum, white coke material, 50% full.
X	S	170	Lead Bearing	Drum	54.00	382296	Note; TD right: "≈ 180 fiber drums w/ lead scrap & lead oxide, 100% full.
X	S	171-1	Lead Bearing	Bulk	8.00	56636	Note; TD rear: lead scrap
	S	171-1	Lead Bearing	Drum	21.00	148671	Note; TD left: "≈ 70 steel drums w/ lead hard head, lead scrap, 100% full.
	S	171-2	Lead Bearing	Bulk	8.00	56636	Note; TD right: lead scrap
	S	171-3	Lead Bearing	Drum	0.06	425	Note; TD right: one drum 20% full.
	S	171-4	Lead Bearing	Drum	0.21	1487	in the area of "Bin #3", one drum 70% full, hard head.
	L	172	Petroleum	Tank	4.44	7484	Hydr. Fluid Tank, adj. hydr. oil tank.
X	S	173	Lead Bearing	Bulk	40.00	283182	Note; TD left: "Mill Scale Bulk".
	L	174	Petroleum	Pail	0.09		Note; TD right: three capped pails of used oil, 100% full.
	S	175	Lead Oxide	Tank	11.39	56498	containing lead oxide, Acid tanks
	S	176	BHB	Bulk	3.00	21239	in front of "Bin #1".
X	L	177	Water	Tank	1.80	3034	approx. vol. 375 GAL. (50 CF).
X	S	177	Lead Oxide	Pit	18.40	130264	approx. slag vol. 6.0 CF, lead oxide vol. 490 CF. acid tank
	S	178	Slag Stone	Bulk	3.00	21239	in the area of "Bin #2".
X	S	179	Hard Rubber	Bulk	60.00		in the area of "Bin #2".
	S	180	Plast.Batt.Case	Drum	0.30		in the area of "Bin #2", one drum 100% full.
	S	181	Dross (red)	Drum	2.70	27307	in the area of "Bin #3", nine drums 100% full, "Hard Pack".
	S	181	Dross (red)	Drum	0.30	3034	in the area of "Bin #4", #?, 100% full, Hard Pack.

Table 1
(continued)
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Waste Inventory

SAMPLED	STATE	NUMBER	MATERIAL TYPE	CONTAINER	VOLUME (cu yd)	MASS (lbs.)	DESCRIPTION
	S	181	Dross (red)	Drum	2.70	27307	in the area of "Bin #3", nine drums 100% full, "Hard Pack".
	S	181	Dross (red)	Drum	0.30	3034	in the area of "Bin #4", #7, 100% full, Hard Pack.
X	S	181	Dross (red)	Bulk	3.60	36409	12 drums in the area of "Bin #3", 100% full
X	S	182	?	Drum	3.30	23363	in the area of "Bin #3", 22 drums 50% full.
X	S	183	Dross (black)	Drum	2.70	27307	in the area of "Bin #3", black color, 10 drums 30%-90% full.
X	S	184	?	Drum	0.20		in the area of "Bin #3", liquid top black solid below, odor, 70% full.
X	S	185	Lead Oxide	Bulk	30.00	212387	in the area of "Bin #3".
	S	186	Slag/Lead Scrap	Bulk	78.00	552206	in the area of "Bin #3".
X	S	187	Dross (yellow)	Drum	0.20	2023	in the area of "Bin #3", one drum yellow dross material, 100% full.
X	S	188	Lead Bearing	Bulk/Drum	100.00	707956	in the area of "Bin #3", hard head, slag drums, lead oxide, scrap mat.
X	S	189	Scrap Wood	Bulk	50.00	8500	in the area of "Bin #3", misc. clean up debris.
	S	190	Lead Bearing	Bulk	30.00	212387	in the area of "Bin #3", piled hard head material.
X	S	191	Lead Bearing	Bulk	200.00	1415912	in the area of "Bin #4", piled hard hard material.
	S	192	Lead Oxide	Tank	2.00	14159	tank, volume 130 gal., only solid present.
	S	193	Lead Bearing	Drum	0.15	743	one drum 50% full.
	S	193	Lead Bearing	Lead mold	0.25	1770	one pot 50% full.
	S	194	Slag	Bulk	5.00	24780	Slag crusher bag house
	L	195	Petroleum	Drum	0.18		three drums 20% full.
X	L	196	Water	Bulk	1336.89	2237953.86	Hoffmans pond. pond of rain water
X	L	197	Water	Tank	3.70	6193.80	Oil water separator for the fuel station
X	L	198	Water	Tank	8.89	14881.86	Wheel wash station holding tank
X	L	199	Water	Tank	88.89	148801.86	Rain water collected in truck scale
X	L	200	Water	Tank	0.48	803.52	Water in Laboratory Tank
X	L	201	Water	Tank	37.23	62323.02	Shower collection Tank, full
	L	202	Water	Tank	2.90	4854.60	Septic Transfer Tank
X	L	203	Water	Tank	407.40	681987.60	Rain water collected in refining basements
X	L	204	Water	Bulk	185.00	309690.00	Rain collected in truck dock - shipping dock
X	L	205	Water	Bulk	92.75	155263.50	Rain collected in truck cut - recieving dock
X	L	206	Water	Tank	62.96	105395.04	Rain collected in truck dump station - truck lift
	S	207	Dross(yellow)	Bulk	592.59	4195833.46	Tinny dross in dross bins adjacent to location 87-5
	L	208	Petroleum	Tank	7.92		Two large 25000 gal. white No. 2 fuel tanks lying horizontal
	L	209	Petroleum	Tank			Underground Diesel tank, amount to be determined by S. Holt.
	L	210	Petroleum	Tank			Two adjacent gasoline tanks (1-leaded+1-unleaded) amount to be determined by S. Holt
X	L	211	Petroleum	Tank	1.10		Hydraulic fluid in hydraulic drive for shredder
	L	212	Petroleum	Tank	0.18		Hydraulic fluid in portable barrel crusher, next to location #211

Notes:

TBD - To Be Determined.

TD (left or right) - Truck Dump

BHB - Bag House Bags

? - Material Unknown

L - Liquid

S - Solid

X - Sample collected from this Material

Table 2
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
On-Site Liquid Analyses

INVENTORY NUMBER	SAMPLE DATE	SAMPLE NUMBER	pH	LEAD (mg/l)	TOTAL ORGANIC CARBON (mg/l)	GROSS ALPHA (pCi/l)	GROSS BETA (pCi/l)	TOX (ppb)
198	10-4-88	T0432	7.4	0.386	11	< 3	17 +/- 9	<10
196	10-4-88	T0431	6.3	3.39	7	<10	<30	20
200	10-4-88	T0433	6.0	0.407	4			
201	10-4-88	T0434	7.2	1.77	10			
199 (216)	10-4-88	T0441	8.2	0.147	4			
150	10-4-88	T0427	8.1	7.88	1330			
206	10-4-88	T0438	6.2	7.95	7			
177	10-4-88	T0429	7.1	2.64	15			
205	10-4-88	T0437	6.5	3.88	7			
197 (215)	10-4-88	T0440	7.1	0.517	8			
204	10-4-88	T0436	6.4	6.95	2			
68 Dup	10-4-88	T0420	7.5	0.220	6			
122	10-4-88	T0423	6.6	1.62	12			
68	10-4-88	T0419	7.6	0.159	7			
129	10-4-88	T0424	6.5	2.75	9			
211	10-4-88	T0439	6.8	3.45	20			
131	10-4-88	T0425	6.6	9.71	18			
134	10-4-88	T0426	8.7	14.5	107	<40	240 +/- 80	33
203	10-4-88	T0435	7.5	2.89	9	<50	28 +/- 12	<10
168	10-4-88	T0428	5.2	5.90	<1			
97	10-4-88	T0422	7.5	0.147	24			
77	10-4-88	T0421	8.4	3.47	1720			
Rinse Blank	10-3-88	T0442	--	0.169				
Rinse Blank	10-4-88	T0443	--	<0.005				
Rinse Blank	10-4-88	T0444	--	<0.005				

Table 3
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
On-Site Solids Analyses

INVENTORY NUMBER	MATERIAL TYPE	SAMPLE I.D.	LEAD (mg/kg)
28	7	T0379	13
101	Lead	T0387	538000
117	Lead oxide	T0388	237000
118	Lead oxide	T0389	240000
126	Lead bearing	T0390	176000
129	Lead oxide	T0491	181000
132	Lead oxide	T0392	239000
133	Lead oxide	T0393	216000
135	Lead oxide	T0394	428000
136	Lead oxide	T0395	283000
138	Dross	T0396	280000
171-1	Lead bearing	T0403	227000
173	Lead bearing	T0404	826
177	Lead oxide	T0405	205000
179	Lead oxide	T0406	144000
185	Lead oxide	T0411	194000
188	Lead bearing	T0413	200000
189	Scrap wood/pile	T0414	370000
191	Lead bearing	T0415	492000
87-1	Slag	T0383	89000
87-3	Slag	T0384	65000
87-5	Slag	T0385	119000
177 Dup	Lead oxide	T0418	268000

Table 4
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
On-Site Solids Total Metal Analyses

INVENTORY NUMBER	MATERIAL TYPE	SAMPLE I.D.	ARSENIC (mg/kg)	CADMIUM (mg/kg)	CHROMIUM (mg/kg)	COPPER (mg/kg)	LEAD (mg/kg)	ANTIMONY (mg/kg)	SELENIUM (mg/kg)	TIN (mg/kg)	ZINC (mg/kg)
54	Dross (yellow)	T0380	4420	R	J<5	760	282000	9660	R	4250	19
55	Dross (yellow)	T0381	798	R	J<5	890	392000	9260	R	10600	400
62	Dross (brown)	T0382	814	R	338	1910	77900	2290	R	1740	3840
99	Molycorp	T0386	987	R	J38	284	51000	91	R	185	106
151	Lead bearing	T0397	302	R	J<5	11	238000	37	R	<80	36
154	Lead bearing	T0398	228	R	J<5	11	173000	40	R	<80	12
159	Dross	T0399	<100	R	J<5	26	6430	<20	R	<80	61
161	Dross	T0400	654	R	J<5	7	524000	47	R	104	38
163	Lead bearing	T0401	536	R	J416	139	383000	23	R	83	314
170	Lead bearing	T0402	331	R	J<5	<2	250000	26	R	<80	3
181	Dross (red)	T0407	659	R	J<5	649	251000	11000	R	668	368
182	?	T0408	282	R	J<5	9	215000	28	R	<80	16
183	Dross (black)	T0409	155	R	J<5	58	106000	26	R	<80	54
184	?	T0410	267	R	J<5	13	199000	<20	R	<80	29
187	Dross (yellow)	T0412	1070	R	J<5	2	815000	44	R	157	4
207	Dross (yellow)	T0416	<200	R	J92	6260	27400	556	R	2520	6590

NOTE: All values reported as mg/kg (ppm) on a dry weight basis

R - Results Dated Rejected During Data Validation

J - Results Should be Considered Approximate

Table 5
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Slag EP Toxicity Analyses

Inventory Number	87-1	87-3	87-5	87-1(Dup.)	RCRA
Sample date	10-4-88	10-3-88	10-3-88	10-4-88	Hazard
Sample Number	T0445	T0446	T0447	T0417	Criteria
=====					
Silver	<0.5	<0.5	<0.5	<0.5	5.0
Arsenic	<0.5	<0.5	<0.5	<0.5	5.0
Barium	<10.0	<10.0	<10.0	<10.0	100.0
Cadmium	1.5	1.0	0.5	1.8	1.0
Chromium	<0.5	<0.5	<0.5	<0.5	5.0
Mercury	<0.0005	0.0014	<0.0005	0.001	0.2
Lead	30.0	2.1	3.2	2.0	5.0
Selenium	<0.1	<0.1	<0.1	<0.1	1.0

NOTE: All values reported as mg/l in leachate

TABLE 6
NATIONAL SMELTING OF NEW JERSEY, INC./
NL INDUSTRIES, INC. SITE
LEACHATE SAMPLES (mg/l)

Sample ID	I9176	I9186	I9175	I9177
Date	8/15/89	8/15/89	8/15/89	8/15/89
Location	Primary A	Secondary A	Primary B	Secondary B
pH	11.47	11.2	7.4	6.0
Conductivity	>50,000	>50,000	13,500	40,000
<u>Analytes:</u>				
Aluminum	J 82.5	J 5.47	J 0.606	J 9.63
Antimony	J 82.7	J 2.34	J 0.108	J 0.063
Arsenic	218	174	0.972	0.024
Barium	J 0.492	J 0.030	J 0.030	J 0.013
Beryllium	0.018	<0.01	<0.01	0.001
Cadmium	<0.020	<0.020	2	0.004
Calcium	61.3	11.9	274	201
Chromium	J 3.47	J 155	J 53	J 0.035
Cobalt	0.151	0.050	0.006	0.035
Copper	J 0.154	J <0.05	J <0.005	J 0.02
Iron	J 271	J 16.3	J 74.8	J 153
Lead	<0.030	<0.030	J 254	<0.030
Magnesium	12.4	2.9	96.9	84.3
Manganese	5.57	1.39	9.650	7.23
Mercury	<0.002	<0.002	<0.002	<0.002
Nickel	J 0.795	J 0.688	J 0.040	J 0.072
Potassium	J 87.9	J 102	J 26.5	J 14.5
Selenium	R	R	R	R
Silver	0.102	0.028	<0.020	0.012
Sodium	J 34,000	J 33,900	J 3,330	J 1,260
Thallium	J <0.050	<0.050	<0.005	<0.050
Vanadium	40.4	32.8	0.016	0.007
Zinc	0.752	0.919	12	1.81
Cyanide	<0.010	<0.010	<10	<0.010
TOC	R	R	R	R
TOX	<2.0	<2.0		
Gross Alpha	<2.0	<0.6	<0.07	<0.04
Gross Beta	<4.0	<1.0	<0.1	<0.09

Note: All values expressed in mg/l except for pH conductivity (μ mhos/cm) and Gross Alpha and Beta (pCi/l). 'R' indicates data rejected during validation, while 'J' indicates an approximate value.

Table 8
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Surface Water and Sediments Analyses (1988)

SAMPLE ID	LOCATION ID	SAMPLE DATE	SAMPLE TYPE	FLOW STATE	pH	LEAD (1) (mg/L)
=====						
T0043	401	8/19/88	water	low	6.00	0.098
T0043	401	8/19/88	water	low	N/A	0.114
T0044	402	8/19/88	water	low	4.00	1.240
T0045	403	8/19/88	water	low	4.00	0.263
T0046	405	8/19/88	water	low	5.50	0.025
T0047	406	8/19/88	water	low	6.00	0.011
T0138	401	9/13/88	water	high	5.30	0.1
T0124	402	9/13/88	water	high	3.40	1.06
T0136	403	9/13/88	water	high	3.30	0.088
T0126	404	9/13/88	water	high	3.00	2.18
T0134	405	9/13/88	water	high	3.60	0.021
T0132	406	9/13/88	water	high	6.40	0.0117
T0103	408	9/13/88	water	high	3.50	3
T0101	409	9/13/88	water	high	3.40	1.98
T0099	411	9/13/88	water	high	4.30	0.0232
T0139	401	9-13-88	sediment			817
T0125	402	9-13-88	sediment			1640
T0137	403	9-13-88	sediment			3060
T0127	404	9-13-88	sediment			702
T0135	405	9-13-88	sediment			4350
T0133	406	9-13-88	sediment			<5
T0102	408	9-13-88	sediment			286
T0100	409	9-13-88	sediment			552
T0098	411	9-13-88	sediment			77.5

NOTE: N/A - Not Analyzed
(1) mg/kg for sediment

Table 9
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Surface Water Quality Analyses (1989)

SAMPLE ID	LOCATION ID	SAMPLE DATE	LEAD (mg/l)	ANTIMONY (mg/l)	ARSENIC (mg/l)	CADMIUM (mg/l)	CHROMIUM (mg/l)	COPPER (mg/l)	SELENIUM (mg/l)	ZINC (mg/l)	TIN (mg/l)	SULFATE (mg/l)	CHLORIDE (mg/l)	pH	CONDUCTIVITY (umhos/cm)
J2611	ES-1	10/17/89	J.010									600	230	7.2	2200
J2612	ES-2	10/17/89	R									100	55	7.3	450
J2618	ES-3	10/17/89	R									57	<25	7.4	120
J2615	ES-5	10/17/89	R									30	<25	7.2	260
J2609	ES-6	10/17/89	.101									19	<25	7.3	110
J2617	ES-7	10/17/89	R									73	<25	7.2	120
J2606	WS-1	10/16/89	J.049									170	<25	7.0	430
J2607	WS-2	10/16/89	J.069									170	<25	7.1	415
J2608	WS-3	10/16/89	J.085									180	<25	7.2	420
J2602	WS-4	10/16/89	J.064									170	<25	7.1	520
J2601	WS-5	10/16/89	.313									230	<25	7.0	680
J2604	WS-6	10/16/89	J.078									240	<25	7.0	700
J2603	WS-7	10/16/89	.408									1,200	<25	6.7	3200
J2600	WS-8	10/16/89	.414									740	<25	6.6	900
J2597	WS-9	10/16/89	1.270	J.079	.060	.014	.016	.039	J<.010	.162	<.800	460	<25	6.6	1200
J2605	WS-11	10/16/89	.190									34	<25	6.9	220
J2624	WS-12	10/17/89	J2.200									9	<25	7.2	130
J2610	WS-16	10/17/89	.244									140	<25	7.2	340
J2616	WS-17	10/17/89	J.418									140	<25	7.4	360

Note: R = Indicates data rejected based on data validation
J = Indicates results should be considered approximate

Table 10-1
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Surface Water Sediment Sample Analyses (1989)

Sample ID	Location	Date	Lead (mg/kg)	Sample ID	Location	Date	Lead (mg/kg)
J3043	ES-1 (0-3)	10/17/89	13.9	J3074	WS-7 (0-3)	10/16/89	J1870.0
J3046	(3-6)	10/17/89	21.8	J3075	(3-6)	10/17/89	J5540.0
J3047	(6-8)	10/17/89	28.2	J3076	(6-12)	10/17/89	J235.0
J3043	ES-2 (0-3)	10/17/89	251.0	J3077	(12-19)	10/17/89	J8.6
J3044	(3-6)	10/17/89	49.4	J3036	WS-8 (0-3)	10/16/89	J1310.0
J3061	ES-3 (0-3)	10/17/89	22.8	J3037	(3-6)	10/16/89	490.0
J3062	(3-6)	10/17/89	20.8	J3038	(6-9)	10/16/89	19.6
J3080	ES-4 (0-3)	10/17/89	J628.0	J3029	WS-9 (0-3)	10/16/89	J6403.9
J3081	(3-6)	10/17/89	J177.0	J3030	(3-6)	10/16/89	899.1
J3082	(6-11)	10/17/89	J39.7	J3031	(6-9)	10/16/89	28.9
J3060	ES-5 (0-3)	10/17/89	J206.0	J3055	WS-10 (0-3)	10/17/89	J2470.0
J3063	ES-6 (0-3)	10/17/89	36.9	J3056	(3-6)	10/17/89	J247.0
J3064	(3-6)	10/17/89	73.0	J3057	(6-12)	10/17/89	J61.5
J3065	(6-10)	10/17/89	159.0	J3058	(12-20)	10/17/89	J13.9
J3066	ES-7 (0-3)	10/17/89	536.0	J3098	WS-11 (0-3)	10/16/89	J23700.0
J3067	(3-6)	10/17/89	44.4	J3099	(3-6)	10/16/89	59700.0
J3068	(6-8)	10/17/89	J38.3	J3100	(6-10)	10/16/89	702.0
J3039	WS-1 (0-3)	10/16/89	J1350.0	J3048	WS-12 (0-3)	10/17/89	J1860.0
J3040	(3-6)	10/16/89	J551.0	J3049	(3-6)	10/17/89	589.0
J3041	(6-12)	10/16/89	J225.0	J3050	(6-10)	10/17/89	140.0
J3042	(12-20)	10/16/89	J14.6	J3083	WS-13 (0-3)	10/17/89	J171.0
J3032	WS-2 (0-3)	10/16/89	J2800.0	J3084	(3-6)	10/17/89	J50.0
J3033	(3-6)	10/16/89	J542.0	J3085	(6-12)	10/17/89	J31.0
J3034	(6-12)	10/16/89	J180.0	J3086	(12-16)	10/17/89	J9.6
J3035	(12-15)	10/16/89	J357.0	J3087	WS-14 (0-3)	10/17/89	J275.0
J3091	WS-3 (0-3)	10/16/89	J816.0	J3088	(3-6)	10/17/89	2870.0
J3092	(3-6)	10/16/89	J2220.0	J3089	(6-12)	10/17/89	145.0
J3093	(6-12)	10/16/89	J329.0	J3090	(12-17)	10/17/89	8.7
J3094	(12-15)	10/16/89	108.0	J3071	WS-15 (0-3)	10/17/89	J246.0
J3051	WS-4 (0-3)	10/17/89	J1970.0	J3072	(3-6)	10/17/89	J1380.0
J3052	(3-6)	10/17/89	J1570.0	J3073	(6-8)	10/17/89	J250.0
J3053	(6-12)	10/17/89	J400.0	J3078	WS-16 (0-3)	10/17/89	J1590.0
J3054	(12-18)	10/17/89	J72.4	J3079	(3-5)	10/17/89	J1600.0
J3025	WS-5 (0-3)	10/16/89	J1350.0	J3095	WS-17 (0-3)	10/16/89	J1890.0
J3026	(3-6)	10/16/89	J1000.0	J3096	(3-6)	10/16/89	110.0
J3027	(6-12)	10/16/89	J72.5	J3097	(6-9)	10/16/89	33.7
J3028	(12-14)	10/16/89	18.5	J3069	DUP ES-2 (0-3)	10/17/89	J35.4
J3059	WS-6 (0-3)	10/17/89	J897.0	J3070	DUP ES-2 (3-5)	10/17/89	J15.3

Note: J indicates that data is considered approximate

Table 10-2
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Supplemental Surface Water Sediment Analyses

SAMPLE ID	LOCATION	SAMPLE DATE	LEAD	ANTIMONY (mg/kg)	ARSENIC (mg/kg)	CADMIUM (mg/kg)	CHROMIUM (mg/kg)	COPPER (mg/kg)	SELENIUM (mg/kg)	ZINC	TIN
J3029	WS-9 (0-3)	10/16/89	J6403.9	J477.8	J280.3	J21.2	J49.3	J187.2	J2.7	J280.8	J<394.1
J3030	WS-9 (3-6)	10/16/89	899.1	J113.8	62.0	4.2	18.3	J73.4	0.7	J69.7	<146.8
J3031	WS-9 (6-9)	10/16/89	28.9	J30.4	3.8	2.0	9.1	J33.4	0.5	J12.2	<121.6

Note: J - indicates data is approximate

Elevated detection limits are due to matrix interferences at the time of analysis

Table 11
NATIONAL SMELTING OF NEW JERSEY, INC./
NL INDUSTRIES, INC. SITE
SOIL SUPPLEMENTAL METAL ANALYSES

Sample ID	Sample Type	Coordinates Horiz.-Vert.	Sample Date	Laboratory Number	Sample Depth(in.)	Arsenic mg/kg	Antimony mg/kg	Cadmium mg/kg	Chromium mg/kg	Copper mg/kg	Selenium mg/kg	Tin mg/kg	Zinc mg/kg
32	Off-site	7330-10490	9/14/88	T0217	0-3	5.69	<20	<1	7.87	6.83J	<0.5J	<80	16.7
22	Off-site	8280-9710	9/14/88	T0201	0-3	6.31	<20	<1	5.86	5.60J	<0.5J	<80	14.8
3	Off-site	9340-7380	9/14/88	T0359	0-3	1.65	<20	<1	7.04	3.25J	<0.5J	<80	21.0
36	Off-site	9570-11400	9/15/88	T0341	0-3	3.68	<20	<1	5.64	5.29J	<0.5J	<80	14.4
37	Off-site	10510-11450	9/15/88	T0337	0-3	5.63	<20	<1	11.1	10.1	<0.5J	<80	32.8
18	Off-site	8250-8900	9/15/88	T0321	0-3	2.15	<20	<1	6.08	4.06J	<0.5J	<80	21.5
212	On-site	8470-9120	9/13/88	T0128	0-3	6.68	<20J	<1	11.3	15.1	<0.5J	<80	23.3
15	Off-site	7400-8890	9/12/88	T0078	0-3	9.63	<20	<1	6.26	8.79	<0.5J	<80	38.1
203	On-site	8700-8360	9/12/88	T0058	0-3	4.45	<20	<1	19.2	5.32J	<0.5J	<80	29.6
220	On-site	9570-9610	9/14/88	T0161	0-3	11.8	110	3.50	9.38	16.4	<0.5J	<80	30.1
221	On-site	8740-9750	9/14/88	T0153	0-3	11.6	25	3.32	8.29	24.2	<0.5J	<80	57.2
204	On-site	8930-8370	9/14/88	T0185	0-3	3.90	<20	<1	7.47	5.00J	<0.5J	<80	17.0
207	On-site	9040-8560	9/14/88	T0189	0-3	2.72	<20	<1	5.93	6.98J	<0.5J	<80	15.8
4	Off-site	10270-7440	9/16/88	T0363	0-3	3.03	<20	<1	10.5	4.34J	<0.5J	<80	22.0
217	On-site	9470-9400	8/17/89	19425	18-24	2.78J	0.6J				<0.1J		
217 Dup	On-site	9470-94008	8/17/89	19428	18-24	2.04J	<3.0J				<0.1J		

J - indicates that data is approximate.

Table 12
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Soil Analysis

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration mg/kg dry weight

201	on-site	9-12-88	T0050	0-3	21
		9-12-88	T0051	3-6	12
202	on-site	9-12-88	T0054	0-3	19
		9-12-88	T0055	3-6	15
203	on-site	9-12-88	T0058	0-3	25
		9-12-88	T0059	3-6	16
204	on-site	9-14-88	T0185	0-3	153
		9-14-88	T0186	3-6	45
205	on-site	9-14-88	T0062	0-3	29
		9-14-88	T0063	3-6	18
206	on-site	9-14-88	T0181	0-3	60
		9-14-88	T0182	3-6	30
207	on-site	9-14-88	T0189	0-3	100
		9-14-88	T0190	3-6	26
208	on-site	9-12-88	T0066	0-3	22
		9-12-88	T0067	3-6	16
209	on-site	9-14-88	T0173	0-3	634
		9-14-88	T0174	3-6	756
		9-14-88	T0175	6-12	131
		9-14-88	T0176	12-18	83
210	on-site	9-12-88	T0070	0-3	33
		9-12-88	T0071	3-6	25
211	on-site	9-14-88	T0169	0-3	7500
		9-14-88	T0170	3-6	5910
		9-14-88	T0171	6-12	5320
		9-14-88	T0172	12-18	1820
		8-17-89	19418	18-24	22.3
		8-17-89	19419	24-30	45.3
212	on-site	9-13-88	T0128	0-3	333
		9-13-88	T0129	3-6	172
		9-13-88	T0130	6-12	68
		9-13-88	T0131	12-18	34
213	on-site	9-12-88	T0074	0-3	1800
		9-12-88	T0075	3-6	2040
		9-12-88	T0076	6-12	R
		9-12-88	T0077	12-18	R
		8-17-89	19430	18-24	891
214	on-site	9-14-88	T0140	0-3	572
		9-14-88	T0141	3-6	120
215	on-site	9-14-88	T0193	0-3	1730
		9-14-88	T0194	3-6	383
		9-14-88	T0195	6-12	39
		9-14-88	T0196	12-18	28

Table 12
(continued)
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Soil Analysis

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration mg/kg dry weight
216	on-site	9-14-88	T0144	0-3	2080
		9-14-88	T0145	3-6	165
217	on-site	9-14-88	T0165	0-3	12700
		9-14-88	T0166	3-6	12300
		9-14-88	T0167	6-12	6880
		8-17-89	19424	12-18	2940
		8-17-89	19425	18-24	231
		8-17-89	19426	24-30	302
217 Dup	on-site	8-17-89	19427	12-18	246
		8-17-89	19428	18-24	102
		8-17-89	19429	24-30	173
218	on-site	9-14-88	T0197	0-3	9340
		9-14-88	T0198	3-6	1620
		9-14-88	T0199	6-12	4370
		9-14-88	T0200	12-18	R
		8-17-89	19420	18-24	2.91
		8-17-89	19421	24-30	6.01
219	on-site	9-14-88	T0149	0-3	740
		9-14-88	T0150	3-6	99
220	on-site	9-14-88	T0161	0-3	3590
		9-14-88	T0162	3-6	2840
		9-14-88	T0163	6-12	R
		9-14-88	T0164	12-18	R
		8-17-89	19422	18-24	15.9
		8-17-89	19423	24-30	51.5
221	on-site	9-14-88	T0153	0-3	1580
		9-14-88	T0154	3-6	793
		9-14-88	T0155	6-12	117
		9-14-88	T0156	12-18	49
222	on-site	9-14-88	T0157	0-3	4610
		9-14-88	T0158	3-6	226
		9-14-88	T0159	6-12	84
		9-14-88	T0160	12-18	152
223	on-site	9-14-88	T0177	0-3	1220
		9-14-88	T0178	3-6	170
		9-14-88	T0179	6-12	56
		9-14-88	T0180	12-18	20
301	on-site	9-13-88	T0086	0-2	401
302	on-site	9-12-88	T0088	0-2	44.2
303	on-site	9-13-88	T0089	0-2	72.1
304	on-site	9-12-88	T0087	0-2	238
305	on-site	9-13-88	T0090	0-2	367
306	on-site	9-13-88	T0091	0-2	845
307	on-site	9-13-88	T0092	0-2	119
308	on-site	9-13-88	T0093	0-2	1190
308	on-site	9-12-88	T0094	0-2	480

Note: R - indicates data rejected based on data validation

Table 13
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Soil Analysis

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration mg/kg dry weight
=====					
1	off-site	9-16-88	T0371	0-3	22.8
		9-16-88	T0372	3-6	12.9
1	off-site dup	9-16-88	T0375	0-3	31.2
		9-16-88	T0376	3-6	11.5
2	off-site	9-16-88	T0367	0-3	58.6
		9-16-88	T0368	3-6	24.6
3	off-site	9-16-88	T0359	0-3	35.7
		9-16-88	T0360	3-6	29.7
4	off-site	9-16-88	T0363	0-3	89
		9-16-88	T0364	3-6	23.1
5	off-site	9-16-88	T0355	0-3	55.4
		9-16-88	T0356	3-6	13.4
6	off-site	9-15-88	T0289	0-3	538
		9-15-88	T0290	3-6	88.8
		9-15-88	T0291	6-12	44.4
		9-15-88	T0292	12-18	25
7	off-site	9-15-88	T0285	0-3	685
		9-15-88	T0286	3-6	215
		9-15-88	T0287	6-12	133
		9-15-88	T0288	12-18	21.5
8	off-site	9-15-88	T0281	0-3	121
		9-15-88	T0282	3-6	41.5
9	off-site	9-15-88	T0309	0-3	48.4
		9-15-88	T0310	3-6	23.1
10	off-site	9-15-88	T0305	0-3	26.6
		9-15-88	T0306	3-6	27.8
11	off-site	9-15-88	T0245	0-3	57.9
		9-15-88	T0246	3-6	43.3
11	off-site dup	9-15-88	T0249	0-3	54.4
		9-15-88	T0250	3-6	42.5
12	off-site	9-15-88	T0233	0-3	72.9
		9-15-88	T0234	3-6	28.4
13	off-site	9-15-88	T0317	0-3	32.3
		9-15-88	T0318	3-6	28.2
14	off-site	9-15-88	T0229	0-3	26.8
		9-15-88	T0230	3-6	26.4
15	off-site	9-12-88	T0078	0-3	32.6
		9-12-88	T0079	3-6	33.1
16	off-site	9-12-88	T0082	0-3	130
		9-12-88	T0083	3-6	21
17	off-site	9-15-88	T0213	0-3	175
		9-15-88	T0214	3-6	44.5

Table 13
(continued)
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Soil Analysis

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration mg/kg dry weight
=====					
18	off-site	9-15-88	T0321	0-3	46
		9-15-88	T0322	3-6	29.2
19	off-site	9-15-88	T0329	0-3	45.3
		9-15-88	T0330	3-6	29.5
20	off-site	9-15-88	T0325	0-3	88.4
		9-15-88	T0326	3-6	38.1
21	off-site	9-15-88	T0205	0-3	41.2
		9-15-88	T0206	3-6	40.3
22	off-site	9-15-88	T0201	0-3	46.3
		9-15-88	T0202	3-6	50.8
24	off-site	9-13-88	T0112	3-6	367
		9-13-88	T0113	3-6	132
25	off-site	9-13-88	T0120	0-3	307
		9-13-88	T0121	3-6	317
		9-13-88	T0122	6-12	244
		9-13-88	T0123	12-18	80.6
26	off-site	9-13-88	T0116	0-3	68.4
		9-13-88	T0117	3-6	62.8
27	off-site	9-15-88	T0333	0-3	206
		9-15-88	T0334	3-6	226
		9-15-88	T0335	6-12	142
		9-15-88	T0336	12-18	59.8
28	off-site	9-15-88	T0209	0-3	275
		9-15-88	T0210	3-6	106
29	off-site	9-13-88	T0104	0-3	161
		9-13-88	T0105	3-6	103
30	off-site	9-13-88	T0108	0-3	81.6
		9-13-88	T0109	3-6	74.4
31	off-site	9-15-88	T0241	0-3	77.9
		9-15-88	T0242	3-6	78.2
32	off-site	9-15-88	T0217	0-3	48.1
		9-15-88	T0218	3-6	21.5
33	off-site	9-15-88	T0237	0-3	32.7
		9-15-88	T0238	3-6	32.6
34	off-site	9-15-88	T0221	0-3	30.9
		9-15-88	T0222	3-6	31.6
35	off-site	9-15-88	T0225	0-3	22.9
		9-15-88	T0226	3-6	25.7
36	off-site	9-13-88	T0341	0-3	40.9
		9-13-88	T0342	3-6	40.2

TABLE 14
Southwest New Jersey Stratigraphy

System	Series	Formation and member	Symbol	Maximum Thickness (feet)	Physical character	Water-bearing character
Quaternary	Recent	Alluvium	Qal	72	Flood plain and channel deposits of clay, silt, sand, and some gravel.	Not important as a source of ground water; generally less permeable than underlying deposits; impedes the movement of water into and out of surface streams.
		- - - Unconformity - - -				
	Pleistocene	Cape May formation (Illinoian)	Qcm	80	Chiefly gray and brown sand and gravel; some silt; little clay. Cape May unweathered. Pensauken deeply weathered.	An important source of ground water in southeast Bucks County. Contains highly permeable sand and gravel beds which yield large quantities of water to wells. Favorably situated with respect to recharge; subject to surface contamination.
		Pensauken formation (Illinoian)	Qp			
Cretaceous	Upper Cretaceous	- - - Unconformity - - -				
		Magothy Formation	Km	10	Medium to coarse gray sand with plant remains.	Unimportant as a source of water in Pennsylvania owing to its small areal extent.
		- - - Unconformity - - -				
		Upper clay member	Kru	35	Chiefly red, white, gray, and yellow clay. Also brown and blue clay; silty, sandy, and pebbly in places.	Acts chiefly as a confining bed.
		- - - Unconformity - - -				
		Old Bridge sand member	Kro	55	Chiefly brown, gray, white, and yellow sand with some gravel; contains some clay and silt in Bucks County.	An excellent aquifer; forms an extensive water table aquifer interconnected with the Pleistocene sediments. Generally not tapped by wells in areas where it occurs beneath an upper confining bed.
		- - - Unconformity - - -				
		Middle clay member	Krm	60	Chiefly red and white clay; also gray, yellow, blue, and brown clay; sandy in places.	An extensive confining bed.
		- - - Unconformity - - -				
		Sayreville sand member	Krs	49	Chiefly brown, yellow, white, and gray sand and gravel; little clay.	Generally not tapped by wells. Potentially an important aquifer in Bucks County.
		- - - Unconformity - - -				
		Lower clay member	Krl	61	Chiefly red clay, also gray, blue, white, and brown clay; sandy in places.	An extensive confining bed.
		- - - Unconformity - - -				
		Farrington sand member	Krf	87	White, yellow, gray, and brown sand and gravel; some white clay.	The principal source of ground water in the Philadelphia area; average permeability 1,000 gpd per sq. ft. as determined by pumping tests. Yields from 500 to 1,000 gpm to wells in South Philadelphia.
		- - - Unconformity - - -				
Pre-Cretaceous	Glenasm	Crystalline rocks	P	1	Mica schist capped by residual weathered clay.	Poor aquifer in the Coastal Plain area; contains some ground water in secondary fractures; average yield less than 50 gpm.

Reference: Greenman, et.al., 1961

Table 15
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Ground Water Elevations

WELL ID	SCREEN LENGTHS FT	TOP OF CASING FT MSL	WELL DEPTH FT	8/15/88 WATER FT MSL	10/27/88 WATER FT MSL	12/23/88 WATER FT MSL	12/23/89 WATER FT MSL
1R	28.00	15.26	32.00		6.00	6.75	
2R2	7.00	11.08	22.10	3.84	3.44	4.42	4.17
3R	29.00	16.04	34.79	4.64	4.14	5.14	4.96
4R	12.00	16.74	23.89	5.25	4.64	5.55	5.37
5R	9.00	11.97	18.96	5.21	5.22	5.83	5.58
6	10.00	14.17	23.50		5.75	5.76	6.02
7	10.00	13.04	49.38	1.55	0.79	1.39	1.38
8R	7.00	18.49	110.90		-13.51	-13.10	-13.90
9R2	8.00	18.67	67.70	-4.49	-6.13	-5.78	-6.12
10	30.00	15.66	72.42	-2.30	-3.49	-3.21	-3.50
11	20.00	11.19	53.99	5.94	5.79	6.33	6.16
12	20.00	12.81	78.18	-2.05	-3.49	-3.02	-3.30
13	20.00	11.59	110.00				-15.32
14	20.00	11.39	46.00				3.11
15	15.00	11.32	22.00				4.90
16	20.00	10.79	54.00				-0.68
17	15.00	9.31	21.00				3.85
18	20.00	12.04	54.00				5.75
AR	30.00	13.33	35.00				
BR	6.00	10.82	38.85	5.78	5.47	5.99	5.78
CR2	6.00	17.90	33.55	5.37	3.62	4.64	4.60
HD	15.00	18.67	41.50	5.48	3.92	4.73	4.65
HS	15.00	18.77	26.44	5.48	3.87	4.71	4.65
ID	25.00	17.18	35.41	6.81	5.40	6.38	6.14
IS	10.00	17.35	15.50			8.71	
JD	10.00	14.02	27.44	6.56	5.57	6.57	6.19
JS	10.00	13.89	17.00		5.54	6.53	6.15
KD	10.00	13.64	27.47	6.49	5.63	6.54	6.16
KS	10.00	12.45	17.78	6.56	2.70	6.61	6.25
LD	7.00	12.83	18.71	5.20	4.58	5.92	5.66
LS	7.00	12.68	13.05		4.93	6.29	6.08
MD	8.00	10.31	19.69	4.02	3.79	4.70	4.45
MS	7.00	11.77	12.11	5.34	3.82	4.72	4.49
ND	10.00	12.29	24.20	5.04	4.84	5.55	5.31
NS	10.00	13.24	16.85	4.89	4.86	5.66	
OD	25.00	13.38	37.15	5.40	5.33	5.87	5.59
PD	10.00	12.86	29.75	6.43	6.09	6.62	6.40
PS	10.00	12.19	21.11		6.54	7.08	6.86
QD	10.00	11.08	22.95				
QS	10.00	12.13	15.73	5.64	5.43	6.21	5.82
RD	10.00	15.56	36.03	5.69	4.33	5.93	4.80
RS	15.00	15.78	22.00		7.33	8.04	7.93
SD	12.00	13.39	28.96	6.18	5.54	6.02	
SS	10.00	12.70	16.77	6.46	5.59	6.35	6.10

Note: MSL represents feet above/below mean seal level

Table 16-1
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Ground Water Quality Analyses

SAMPLE ID	WELL ID	SAMPLE DATE	TURBIDITY (NTU)	FILTERED	ANTIMONY (mg/l)	ARSENIC (mg/l)	CADMIUM (mg/l)	CHROMIUM (mg/l)	COPPER (mg/l)	LEAD (mg/l)	SELENIUM (mg/l)	TOC (mg/l)	TOX (ppb)	SO ₄ (mg/l)	CHLORIDE (mg/l)	pH	CONDUCTIVITY (umho/cm)
19180	1R	8/15/89	30	*	N/A	N/A	JO.003	N/A	N/A	J<0.005	N/A	N/A	N/A	2300	N/A	4.1	4400
T0012	2R2	8/17/88	>90	*	<0.03	R	JO.002	JO.008	<0.020	0.004	R	116	32.5	3340	150	6.6	5500
19080	2R2	8/14/89	>90	*	N/A	J18.2	<0.010	N/A	N/A	J<0.001	N/A	N/A	N/A	5800	N/A	8.7	13000
J3684	2R2	11/14/89	N/A	*	N/A	4.9	0.01	N/A	N/A	<0.05	N/A	N/A	N/A	6100	N/A	N/A	9700
T0009	3R	8/16/88	3	*	<0.03	<0.001	0.012	JO.002	<0.020	JO.01	<0.02	3	<10	147	<1	3.6	260
19085	3R	8/14/89	18	*	N/A	N/A	JO.008	N/A	N/A	JO.007	N/A	N/A	N/A	770	N/A	3.1	270
T0007	4R	8/16/88	20	*	R<0.003	0.001	0.047	0.013	<0.020	0.031	<0.02	8	26.5	553	5	4.4	900
19086	4R	8/14/89	4.8	*	N/A	N/A	JO.015	N/A	N/A	JO.011	N/A	N/A	N/A	190	N/A	3.6	650
T0008	5R	8/16/88	45	*	R<0.03	0.001	<0.001	0.012	<0.02	JO.01	<0.02	60	13	283	31	4.3	800
19077	5R	8/14/89	>90	*	N/A	N/A	JO.001	N/A	N/A	JO.013	N/A	N/A	N/A	180	N/A	3.8	460
19078	6	8/14/89	>90	*	N/A	N/A	JO.002	N/A	N/A	0.01	N/A	N/A	N/A	240	N/A	4.5	600
T0010	7	8/16/88	12	*	<0.03	<0.001	0.031	0.014	0.113	JO.008	<0.02	7	<10	647	7	4.2	1000
19181	7	8/16/89	>90	*	N/A	N/A	0.023	N/A	JO.012	J<0.005	N/A	N/A	N/A	490	N/A	5.4	1200
T0032	9R2	8/18/88	45	*	J<0.003	<0.001	<0.001	JO.003	<0.020	JO.003	<0.002	3	<10	3	<1	4.7	80
19380	9R2	8/15/89	N/A	*	N/A	N/A	<0.001	N/A	N/A	R	N/A	N/A	N/A	J2	N/A	5.0	100
T0006	10	8/16/88	>90	*	<0.003	<0.001	0.045	0.010	0.028	0.012	<0.02	10	<10	284	5	4.9	550
19381	10	8/17/89	N/A	*	N/A	N/A	0.041	N/A	N/A	R	N/A	N/A	N/A	J170	N/A	6.0	440
T0003	11	8/15/88	53	*	<0.003	R	0.134	JO.005	0.042	JO.006	R	22	1750	2760	170	5.2	4500
19256	11	8/16/89	N/A	*	N/A	<0.003	0.210	N/A	N/A	R	N/A	N/A	N/A	1800	N/A	5.7	4100
19257	11-Dup	8/16/89	N/A	*	N/A	<0.003	0.213	N/A	N/A	J<0.005	N/A	N/A	N/A		N/A	N/A	N/A
T0011	12	8/16/88	13	*	<0.03	0.002	<0.001	JO.001	<0.020	JO.027	<0.002	1	<10	4	3	8.0	5.2
19182	12	8/15/89	27	*	N/A	N/A	<0.001	N/A	N/A	R	N/A	N/A	N/A	<1	N/A	5.7	125
J2621	13	10/16/89	N/A	*	N/A	J<0.001	J<0.001	JO.003	N/A	R	N/A	N/A	N/A	3	N/A	6.0	75
J2622	14	10/16/89	N/A	*	N/A	J<0.001	J<0.001	R	N/A	R	N/A	N/A	N/A	30	N/A	5.2	115
J2623	15	10/16/89	N/A	*	N/A	J<0.001	<0.001	R	N/A	R	N/A	N/A	N/A	22	N/A	5.2	110
J2619	16	10/17/89	N/A	*	N/A	J<0.001	J<0.001	R	N/A	R	N/A	N/A	N/A	31	N/A	7.0	125
J2620	17	10/17/89	N/A	*	N/A	0.006	<0.001	R	N/A	R	N/A	N/A	N/A	13	N/A	7.0	40
19084	RB-2R2	8/14/89	<5	*	<0.003	J<0.001	<0.001	R	J<0.008	J<0.002	N/A	N/A	N/A	<1	N/A	4.8	<10
19383	RB	8/17/89	N/A	*	N/A	N/A	N/A	N/A	0.003	J<0.003	N/A	N/A	N/A	N/A	N/A	4.8	<10
19183	RB-7	8/15/89	N/A	*	0.003	J<0.001	JO.001	0.003	<0.005	J<0.003	N/A	N/A	N/A	<1	N/A	4.8	N/A

NOTE: N/A - Not Analyzed
RB - Rinse Blank
DUP - Duplicate Sample
J - Indicates data considered approximate based on data validation
R - Indicates data rejected based on data validation

Table 16-2
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Ground Water Quality Analyses

SAMPLE ID	WELL ID	SAMPLE DATE	TURBIDITY (NTU)	FILTERED	ANTIMONY (mg/l)	ARSENIC (mg/l)	CADMIUM (mg/l)	CHROMIUM (mg/l)	COPPER (mg/l)	LEAD (mg/l)	SELENIUM (mg/l)	TOC (mg/l)	TOX (ppb)	SO4 (mg/l)	CHLORIDE (mg/l)	pH	CONDUCTIVITY (umho/cm)
T0004	BR	8/16/88	1.5		<0.003	<0.001	0.015	J0.002	0.039	0.018	<0.02	6	<10	1100	59	5.7	2000
19249	BR	8/16/89	N/A	*	N/A	N/A	J<0.001	N/A	N/A	J 0.005	N/A	N/A	N/A	J89	N/A	4.1	310
T0016	CR2	8/15/88	>90	*	<0.003	<0.001	<0.001	0.010	<0.020	J 0.028	<0.002	7	<10	4	<1	5.7	110
19252	CR2	8/16/89	N/A	*	N/A	N/A	J<0.001	N/A	N/A	J 0.006	N/A	N/A	N/A	J3	N/A	5.7	130
T0040	HD	8/19/88	10	*	0.005	0.003	0.064	0.013	0.040	J 0.079	<0.02	9	27	1140	18	4.2	265
19238	HD	8/16/89	>90	*	J<0.03	N/A	J0.379	N/A	N/A	J 0.009	N/A	N/A	N/A	J650	N/A	10.0	12,500
T0041	HS	8/19/88	>90	*	0.122	0.002	J0.010	J0.003	0.024	J 6.290	<0.002	12	15	84	3	3.8	300
19237	HS	8/16/89	>90	*	J0.092	N/A	J0.0063	N/A	N/A	4.400	N/A	N/A	N/A	J69	N/A	4.4	220
T0025	ID	8/18/88	12	*	J<0.003	<0.001	0.004	0.001	<0.020	J 0.026	<0.02	1	<10	54	<1	3.4	170
19241	ID	8/16/89	N/A	*	N/A	N/A	J0.003	N/A	N/A	J 0.011	N/A	N/A	N/A	J65	N/A	4.0	170
T0024	JD	8/15/88	44	*	<0.03	0.001	0.103	0.027	0.143	0.014	<0.02	8	15	741	5	4.0	510
19242	JD	8/16/89	N/A	*	N/A	N/A	0.049	J0.009	J0.062	J<0.003	N/A	N/A	N/A	270	N/A	3.6	700
T0022	KD	8/18/88	>90	*	J<0.03	R	0.291	0.246	0.513	J 0.061	R	8	61	8460	110	2.5	12,000
19245	KD	8/16/89	N/A	*	N/A	N/A	0.113	J0.081	J0.152	J 0.019	N/A	N/A	N/A	2700	N/A	3.4	500
T0023	KS	8/18/88	>90	*	<0.03	R	0.173	0.060	0.219	3.130	R	28	27.5	3070	57	2.9	5000
19243	KS	8/16/89	N/A	*	N/A	N/A	0.079	J0.016	J0.092	J 2.400	N/A	N/A	N/A	1300	N/A	4.2	N/A
19244	KS-Dup	8/16/89	N/A	*	N/A	N/A	0.078	J0.015	J0.091	J 2.350	N/A	N/A	N/A	1300	N/A	N/A	N/A
T0013	LD	8/17/88	>5	*	<0.03	0.002	J0.002	0.011	<0.020	0.044	<0.02	18	<10	170	<1	4.0	340
19083	LD	8/14/89	2.7	*	N/A	N/A	0.002	N/A	N/A	J 0.024	N/A	N/A	N/A	41	N/A	3.5	120
T0028	MD	8/18/88	>90	*	<0.003	R	0.008	J0.005	<0.020	0.002	R	23	99.5	1730	140	5.7	4000
19081	MD	8/14/89	>90	*	N/A	J<0.001	J0.008	N/A	N/A	J<0.005	N/A	N/A	N/A	570	N/A	4.9	1400
T0029	MS	8/18/88	46	*	J<0.003	<0.001	0.011	J0.004	<0.020	J 0.198	<0.02	14	29	321	5	4.0	700
19079	MS	8/14/89	22	*	N/A	N/A	J0.016	N/A	N/A	J 0.219	N/A	N/A	N/A	N/A	N/A	4.1	700
T0034	ND	8/19/88	22	*	<0.03	0.001	J0.008	0.012	0.068	J 0.064	<0.02	38	58	1580	45	3.4	270
19076	ND	8/14/89	>90	*	N/A	N/A	0.006	N/A	N/A	J 0.014	N/A	N/A	N/A	2000	N/A	3.8	3400
T0037	NS	8/19/88	19	*	<0.03	<0.001	0.009	0.013	<0.020	J 0.045	<0.02	15	97.5	367	3	3.6	710
19075	NS	8/14/89	>90	*	N/A	N/A	0.004	N/A	N/A	J 0.01	N/A	N/A	N/A	200	N/A	3.9	4800
T0036	OD	8/17/88	49	*	<0.03	0.002	J0.002	0.045	<0.020	0.030	<0.02	56	46	5630	48	4.0	10,000
19239	OD	8/16/89	N/A	*	N/A	N/A	J<0.001	J0.121	N/A	J<0.003	N/A	N/A	N/A	980	N/A	4.1	2000
T0001	PD	8/15/88	20	*	J<0.003	0.017	J0.001	J0.002	<0.020	J 0.039	<0.02	11	81.5	1140	100	5.6	2300
19240	PD	8/16/89	<5	*	N/A	0.003	J0.001	N/A	N/A	J 0.009	N/A	N/A	N/A	J740	N/A	5.7	1600
T0035	QS	8/19/88	26	*	<0.003	0.002	0.007	J0.003	<0.020	0.090	<0.002	54	40	328	<1	4.2	335
T0005	RB-BR	8/16/88	N/A		<0.003	0.002	J<0.001	J0.001	<0.020	J 0.004	<0.002	8	<10	25	21	N/A	N/A
T0017	RB-CR2	8/15/88	N/A		<0.003	<0.001	<0.001	0.014	<0.020	J 0.003	<0.002	3	<10	28.3	19	N/A	N/A
T0021	RB-KD	8/18/88	N/A		<0.003	0.001	<0.001	0.011	<0.020	0.002	<0.002	1	<10	28	21	N/A	N/A
T0033	RB-ND	8/19/88	N/A	*	<0.003	0.003	J<0.001	J0.002	<0.020	J 0.002	<0.002	3	<10	25	23	N/A	N/A
T0002	RB-PD	8/15/88	N/A	*	J<0.003	0.002	<0.001	0.001	<0.020	0.007	0.004	7	<10	23	21	N/A	N/A
T0026	RD	8/17/88	>90	*	<0.003	<0.001	<0.001	J0.003	<0.020	J 0.004	0.004	4	<10	46	6	5.0	200
19247	RD	8/16/89	N/A	*	N/A	N/A	J<0.001	N/A	N/A	J<0.001	N/A	N/A	N/A	J32	N/A	5.9	240
19246	RS	8/16/89	N/A	*	N/A	N/A	J<0.001	N/A	N/A	J 0.002	N/A	N/A	N/A	J12	N/A	6.1	170
T0038	SD	8/19/88	>90	*	<0.03	<0.01	1.01	3.250	3.84	0.294	R	N/A	235	N/A	N/A	3.7	20,000
19250	SD	8/16/89	N/A	*	N/A	R	0.963	J4.340	J4.680	J 0.084	N/A	N/A	N/A	24000	N/A	2.3	24,000
19251	SD-Dup	8/16/89	N/A	*	N/A	N/A	0.899	J4.030	J4.360	J 0.06	N/A	N/A	N/A	24000	N/A	N/A	N/A
T0039	SS	8/19/88	81	*	<0.03	0.020	0.119	0.021	0.011	J 0.086	<0.02	91	73	1090	92	4.1	3800
19248	SS	8/16/89	N/A	*	N/A	0.005	J0.015	J0.010	N/A	R	N/A	N/A	N/A	940	N/A	5.4	1800

NOTE: N/A - Not Analyzed

RB - Rinse Blank

DUP - Duplicate Sample

R - Indicates data rejected based on data validation, J - Indicates results should be considered approximate

TABLE 16-3
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Ground Water Quality Analyses

SAMPLE ID	WELL ID	SAMPLE DATE	TURBIDITY (NTU)	FILTERED	ANTIMONY (mg/l)	ARSENIC (mg/l)	CADMIUM (mg/l)	CHROMIUM (mg/l)	COPPER (mg/l)	LEAD (mg/l)	SELENIUM (mg/l)	TOC (mg/l)	TOX (ppb)	SO ₄ (mg/l)	CHLORIDE (mg/l)	pH	CONDUCTIVITY (umho/cm)
T0020	PW2	8/17/88	N/A		<0.003	<0.001	J<0.001	0.011	<0.020	J 0.022	<0.002	5	<10	27	43	6.0	210
19187	PW2	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J<0.001	N/A	N/A	N/A	N/A	N/A	5.7	N/A
T0018	PW3	8/17/88	N/A		<0.003	0.002	J<0.001	J0.009	J0.253	J 0.117	<0.002	<1	N/A	4	12	5.5	135
19184	PW3	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J 0.001	N/A	N/A	N/A	N/A	N/A	5.8	N/A
T0019	PW3-DUP	8/17/88	N/A		<0.003	0.003	J<0.001	J0.005	J0.056	J 0.006	<0.002	4	<10	6	11	N/A	N/A
T0014	PW4	8/17/88	N/A		<0.003	0.006	<0.001	0.013	<0.020	J 0.002	<0.002	5	<10	9.8	9	5.5	140
19178	PW4	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J<0.001	N/A	N/A	N/A	N/A	N/A	5.9	N/A
19179	PW5	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J<0.001	N/A	N/A	N/A	N/A	N/A	6.1	N/A
T0015	PW6	8/17/88	N/A		<0.003	<0.001	J<0.001	0.012	0.057	J 0.008	<0.02	2	<10	27	15	5.4	170
19253	PW6	8/16/89	N/A		N/A	N/A	J<0.001	N/A	N/A	J 0.013	N/A	N/A	N/A	N/A	N/A	4.9	N/A
T0031	PW7	8/18/88	N/A		<0.003	0.003	J<0.001	J0.007	<0.020	J 0.005	<0.02	5	<10	35	25	4.8	235
19255	PW7	8/16/89	N/A		N/A	N/A	<0.001	N/A	N/A	J 0.010	N/A	N/A	N/A	N/A	N/A	5.1	N/A
19185	PW8	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J<0.001	N/A	N/A	N/A	N/A	N/A	6.6	N/A
T0030	PW9	8/18/88	N/A		<0.003	0.002	J0.003	0.011	0.045	J 0.004	<0.002	3	20.5	85	49	4.7	600
19082	PW9	8/14/89	N/A		N/A	N/A	0.002	N/A	N/A	J<0.001	N/A	N/A	N/A	N/A	N/A	5.0	N/A

NOTE: N/A - Not Analyzed

RB - Rinse Blank

DUP - Duplicate Sample

R - Indicates data rejected based on data validation

J - Indicates results should be considered approximate

Table 17
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Ground Water Quality Analyses
Inorganic Priority Pollutants

Well ID Description Date	11 T0003 8/15/88	11 19256 8/16/89	11-DUP 19257 8/16/89	JD T0024 8/18/88	JD 19242 8/16/89	ID T0025 8/18/88	SD T0038 8/19/88	SD 19250 8/16/89	SD-DUP 19251 8/16/89	QS T0035 8/19/88	Blank 8/17/88
Silver	<0.01			<0.01		<0.01	0.044	0.037	0.034	<0.01	<0.01
Arsenic	R			0.001		<0.001	R			0.002	0.002
Beryllium	0.003			0.007		0.003	0.156			0.003	0.003
Cadmium	0.134			0.103		0.004	1.01			0.007	0.001
Chromium	0.005J			0.027		0.001J	3.25			0.003J	0.01
Copper	0.042			0.143		<0.02	3.84			<0.02	<0.02
Mercury	<0.0002			<0.0002		0.0006	0.0003			<0.0002	<0.0002
Nickel	0.063	0.14J	0.139J	0.099	0.064J	<0.04	1.93	2.48	2.31	<0.04	<0.04
Lead	0.006J			0.014		0.026J	0.294			0.090	0.001
Antimony	<0.003			<0.03		<0.003J	<0.03			<0.003	<0.03
Selenium	R			<0.02		<0.02	R			<0.002	<0.002
Zinc	0.297			0.603		0.088	8.64	9.69	9.11	0.018	<0.01
Cyanide	N/A			<0.01		N/A	<0.01			<0.01	<0.01
Thallium	0.001			<0.001		<0.001	0.003			<0.001	<0.001

Note:

J - Indicates data considered appropriate based on data validation

R - Indicates data rejected based on data validation

N/A - Not Analyzed

TABLE 18-1
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Ground Water Analyses - Radiologic Indicators

SAMPLE ID	WELL ID	FILTERED	DATE	GROSS ALPHA	GROSS BETA	TOTAL RADIUM
T0004	BR		8/17/88	<8.0	<20.0	
75562	BR	X	8/16/89	3.6 +/- 1.2		3.8 +/- 1.8
T0016	CR2	X	8/17/88	<1.0	<2.0	
T0040	HD	X	8/18/88	<7.0	<20.0	
75570	HD	X	8/16/89	17.0 +/- 12.0		30.0 +/- 5.0
T0041	HS	X	8/19/88	<3.0	9.3 +/- 6.0	
T0025	ID	X	8/18/88	<1.0	7.1 +/- 1.9	
T0024	JD	X	8/18/88	<8.0	<20.0	
75569	JD	X	8/16/89	<4.0		6.3 +/- 2.6
T0022	KD	X	8/18/88	43.0 +/- 26.0	<100.0	
75575	KD	X	8/16/89	<60.0	<100.0	
T0023	KS	X	8/18/88	<10.0	<60.0	
75577	KS	X	8/16/89	<20.0	<60.0	
75576	KS-DUP	X	8/16/89	<30.0	<60.0	
T0013	LD	X	8/17/88	<4.0	7.6 +/- 3.7	
T0028	MD	X	8/18/88	<10.0	<50.0	
75555	MD	X	8/14/89	<5.0		<2.0
T0029	MS	X	8/18/88	<4.0	<9.0	
T0034	ND	X	8/19/88	8.5 +/- 4.9	27.0 +/- 11.0	
T0037	NS	X	8/19/88	<3.0	<10.0	
T0036	OD	X	8/19/88	<20.0	<40.0	
75557	OD	X	8/16/89	<40.0		100.0 +/- 10.0
T0001	PD	X	8/15/88	<20.0	44.0 +/- 29.0	
75571	PD		8/16/89	<7.0		10.0 +/- 3.0
T0035	QS	X	8/19/88	<3.0	6.0 +/- 2.9	
T0026	RD	X	8/18/88	<3.0	7.7 +/- 2.8	
T0038	SD	X	8/19/88	260. +/- 110.	420. +/- 210.	
75564	SD	X	8/16/89	570.0 +/- 180	580.0 +/- 170.0	
75565	SD-DUP	X	8/16/89	530.0 +/- 180	700.0 +/- 180	
T0039	SS	X	8/19/88	<20.0	<40.0	
75567	SS	X	8/16/89	<20.0		7.0 +/- 2.6
75568	SS-DUP	X	8/16/89			6.6 +/- 2.6
T0005	BR(RB)		8/16/88	<2.0	4.0 +/- 2.4	
T0021	KD(RB)		8/18/88	<3.0	<4.0	
T0033	ND(RB)	X	8/19/88	<5.0	<5.0	
T0002	PD(RB)	X	8/15/88	3.0	3.7 +/- 2.5	
81173	RB		10/17/89	<7.0	1.8 +/- 1.0	

NOTES:

Units in pCi/l

(RB) = Rinse Blank

+/- = Represents the uncertainty of the value determined

TABLE 18-2
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Ground Water Analyses - Radiologic Indicators

Sample ID	Well ID	Filtered	Date	Gross Alpha	Gross Beta	Total Radium
T0012	2R2	X	8/17/88	<20.0	<90.0	
T5566	2R2	X	8/14/89	<70.0	<100.0	
T0009	3R		8/16/88	<4.0	9.0 +/- 3.5	
T0007	4R	X	8/18/88	<3.0	13.0 +/- 8.0	
T0008	5R	X	8/16/88	<4.0	<20.0	
T0010	7	X	8/16/88	<6.0	<20.0	
T5556	7	X	8/15/89	<3.0		3.6 +/- 2.1
T0032	9R2	X	8/18/88	<0.9	<2.0	
T0006	10	X	8/16/88	<4.0	<10.0	
T0003	11	X	8/15/88	<10.0	<50.0	
T5573	11	X	8/16/89	<40.0		61.0 +/- 7.0
T5574	11-DUP	X	8/16/89			67.0 +/- 8.0
T0011	12	X	8/18/88	<2.0	2.6 +/- 1.6	
81170	13	X	10/16/89	<1.0	1.3 +/- 0.2	
81171	14	X	10/16/89	<1.0	6.2 +/- 1.4	
81172	15	X	10/16/89	<1.0	4.5 +/- 1.3	
81169	16	X	10/17/89	<1.0	4.9 +/- 1.4	
81168	17	X	10/17/89	1.0 +/- 0.4	2.1 +/- 0.4	
T0020	PW2		8/17/88	<3.0	<4.0	
T0018	PW3		8/17/88	<1.0	3.1 +/- 1.4	
T0019	PW3		8/17/88	1.6 +/- 1.3	3.4 +/- 1.7	
T0014	PW4		8/17/88	<1.0	<2.0	
T0015	PW6		8/17/88	<1.0	6.5 +/- 1.7	
T0031	PW7		8/18/88	<1.0	4.8 +/- 1/6	
T0030	PW9		8/18/88	<5.0	3.9 +/- 7.0	
81173	RINSE BLANK		10/17/89	<7.0	1.8 +/- 1.0	

NOTE: Units in pCi/l

+/- = Represents the uncertainty of the value determined

Table 19
National Smelting of New Jersey, Inc./
NL Industries, Inc. Site
Ground Water Analyses - Specific Radio Nuclides

Well ID:	2R2	2R2	KS	KS-DUP	KD	RD	SD	SD-DUP	RINSE BLANK	RINSE BLANK
Sample Date:	8/14/89	8/17/88	8/16/89	8/16/89	8/16/89	8/18/88	8/16/89	8/16/89	8/14/89	8/15/89
GR-A	<70	<20.0	<20	<30.0	<60	<3	570 +/- 180	530.0 +/- 180	<0.7	<0.9
GR-B	<100	<90.0	<40	<60.0	<100	7.7 +/- 2.8	580 +/- 170	700.0 +/- 180	<1.0	<2.0
PB-210	<5	<10.0	<5	<4.0	<5	<10	5.6 +/- 3.8	8.5 +/- 3.6	<5.0	<5.0
RA-226	<1	<0.1	<1	<1.0	<1	<0.1	<1	<1.0	<1.0	<1.0
RA-228	<1	1.0 +/- 0.6	1.7 +/- 0.5	1.3 +/- 0.5	1.8 +/- 0.6	<0.8	<80	<0.8	<0.7	<2.0
BE-7	<40		<30	<40.0	<50.0		<40	<50.0	<30.0	<30.0
K-40	<90	14.0 +/- 1.0	<60	<60.0	<40.0	5.3 +/- 0.1	60.6 +/- 32.5	<90.0	<60.0	<50.0
MN-54	<4		<3	<3.0	<3.0		<3	<4.0	<3.0	<3.0
CO-58	<4		<3	<3.0	<4.0		<4	<5.0	<4.0	<3.0
FE-59	<10		<8	<8.0	<10.0		<10	<10.0	<10.0	<8.0
CO-60	<4		<3	<4.0	<3.0		<4	<5.0	<4.0	<4.0
ZN-65	<9		<7	<7.0	<7.0		<8	<9.0	<7.0	<6.0
ZR-95	<5		<4	<4.0	<5.0		<4	<5.0	<4.0	<4.0
RU-103	<6		<4	<5.0	<7.0		<5	<7.0	<5.0	<5.0
RU-106	<30		<30	<30.0	<30.0		<30	<40.0	<30.0	<30.0
I-131	<40		<20	<30.0	<200.0		<30	<40.0	<30.0	<30.0
CS-134	<4		<3	<3.0	<3.0		<3	<5.0	<3.0	<3.0
CS-137	<4		<3	<4.0	<3.0		<4	<5.0	<4.0	<3.0
BA-140	<20		<20	<20.0	<50.0		<10	<20.0	<20.0	<10.0
CE-141	<10		<10	<10.0	<10.0		<10	<10.0	<9.0	<9.0
CE-144	<40		<30	<30.0	<20.0		<30	<40.0	<20.0	<30.0
TH-228	<20	1.3 +/- 0.4	<6	<6.0	<5.0	<2.0	70.2 +/- 7.0	29.0 +/- 13.0	<0.3	<6.0
U-234	24.0 +/- 4.0	3.4 +/- 0.5	1.3 +/- 0.2	1.5 +/- 0.4	2.3 +/- 0.3	<0.2	98.0 +/- 40.0	100.0 +/- 10.0	<0.1	<0.2
TH-230	38.0 +/- 14.0	.48 +/- 0.29	28.0 +/- 3.0	44.0 +/- 9.0	44.0 +/- 11.0	1.1 +/- 0.7	84.0 +/- 15.0	74.0 +/- 17.0	<0.2	<0.6
TH-232	180.0 +/- 30.0	<.07	<0.3	16.0 +/- 7.0	<4.0	.72 +/- 0.57	69.0 +/- 14.0	100.0 +/- 20.0	<0.2	<0.3
U-235	<1.0	.14 +/- 0.1	<0.1	<0.3	<0.1	<0.8	3.6 +/- 0.7	4.3 +/- 0.6	<0.1	<0.2
U-238	22.0 +/- 4.0	3.2 +/- .04	1.1 +/- 0.2	1.1 +/- 0.4	2.1 +/- 0.3	<0.1	100.0 +/- 10.0	100.0 +/- 10.0	<0.1	<0.2

Note: Units in pCi/l

+/- = Represents the uncertainty of the value determined

TABLE 20
MSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN SOIL SAMPLES

Chemical	On-Site		Off-site		Background	
	Range	ND	Range	ND	Geom. mean	Pennsville
Antimony	0.6 - 110	3/7	<20	0/8	NA	NA
Arsenic	2.04 - 11.8	7/7	1.65 - 9.63	8/8	1.18	0.19
Cadmium	<1 - 3.50	2/6	<1	0/8	0.04	0.02
Chromium	5.93 - 19.2	6/6	5.64 - 11.1	8/8	6.27	NA
Copper	5.00 - 24.2	6/6	3.25 - 10.1	8/8	4.77	2.89
Lead	2.91 - 12700	77/77	10.7 - 1770	114/114	12.26	7.77
Zinc	15.8 - 57.2	6/6	14.4 - 38.1	8/8	17.4	23.3

Notes: Concentrations expressed in mg/kg

Background concentrations obtained from NJDEP 1990

ND = Number of Detections

TABLE 21
MSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN SURFACE WATER SAMPLES

Chemical	Reported		Background	
	Range	ND	Range	ND
WEST STREAM				

Antimony	0.0795	1/1	NA	
Arsenic	0.0607	1/1	NA	
Cadmium	0.0140	1/1	NA	
Chloride	12 - 38	11/11	12	1/1
Chromium	0.0160	1/1	NA	
Copper	0.0390	1/1	NA	
Lead	0.0488 - 2.2000	19/19	0.098 - 2.200	4/4
Sulfate	9 - 1200	11/11	9	1/1
Zinc	0.1622	1/1	NA	
EAST STREAM				

Chloride	6 - 230	6/6	6 - 38	2/2
Lead	0.0100 - 0.1010	10/10	0.1000 - 0.1010	2/2
Sulfate	19 - 600	6/6	19 - 30	2/2
PONDED WATER				

Chloride	5 - 8	2/2		
Lead	0.2440 - 3.000	4/4		
Sulfate	140	2/2		

Note: concentrations expressed in mg/l

ND = Number of Detections

NA = Not Available

TABLE 22
MSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN SEDIMENT SAMPLES

Chemical	Reported		Background	
	Range	ND	Range	ND
WEST STREAM				

Antimony	<30.4 - 477.8	2/3	NA	
Arsenic	3.8 - 280.3	3/3	NA	
Cadmium	2.0 - 21.2	3/3	NA	
Chromium	9.1 - 49.3	3/3	NA	
Copper	33.4 - 187.2	3/3	NA	
Lead	8.6 - 59700.0	52/52	9.6 - 1860.0	8/8
Selenium	0.5 - 2.7	3/3	NA	
Zinc	12.2 - 280.8	3/3	NA	
EAST STREAM				

Lead	<5 - 4350	16/16	36.9 - 206.00	4/4
PONDED WATER				

Lead	8.7 - 2870.0	26/26		

Note: concentrations expressed in mg/kg

ND = Numer of Detections

NA = Not Available

TABLE 23
MSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN MONITORING WELLS

Chemical	Reported		Background	
	Range	Hits	Range	Hits
Antimony	<0.003 - 0.122	3/30	NA	
Arsenic	<0.001 - 18.2	21/39	<0.05	0/3
Beryllium	0.003 - 0.156	5/5	NA	
Cadmium	<0.001 - 1.01	46/64	<0.01	0/3
Chromium	0.001 - 4.340	39/39	<0.05	0/3
Copper	0.011 - 4.680	17/33	<0.05	0/3
Lead	<0.001 - 6.290	52/64	<0.005	0/3
Mercury	<0.0002 - 0.0006	2/5	<0.001	0/3
Nickel	<0.04 - 2.48	6.8	NA	
Selenium	<0.002 - 0.004	1/28	<0.01	0/3
Silver	<0.01 - 0.044	2/6	<0.05	0/3
Thallium	<0.001 - 0.003	2/5	NA	
Zinc	0.018 - 9.69	6/6	<0.05 - 0.13	2/3
Chloride	<1 - 150	21/27	13 - 260	3/3
Sulfate	<1 - 24000	61/62	13 - 48	3/3
1,3-Dichlorobenzene	<1 - 1	1/4	<0.5	0/3
1,1-Dichloroethane	<0.5 - 74	1/7	NA	
1,1-Dichloroethene	<0.5 - 170	1/7	<0.5	0/3
Ethylbenzene	<0.5 - 0.5	1/7	NA	
Tetrachloroethene	<0.5 - 180	1/7	<0.5	0/3
Toluene	<0.5 - 1.5	1/7	NA	
1,1,1-trichloroethane	<0.5 - 4700	1/7	<0.5	0/3
vinyl chloride	<1 - 9	1/7	<0.15	0/3
xylene	<0.5 - 1.5	1/7	NA	
Gross alpha	<0.9 - 570+/-180	7/46		
Gross beta	<2 - 580+/-170	17/37		
Total radium	<2 - 100+/-10	8/9		
Pb-210	<5 - 5.6+/-3.8	1/6		
K-40	<40.0 - 14.0+/-1.0	3/6		
Ra-226	<60 - 1.42+/-0.69	1/4		
Ra-228	<0.8 - 1.8+/-0.6	3/6		
Th-228	<2.0 - 7.02+/-0.70	2/6		
Th-230	.48+/- .29 - 44+/-11	4/4		
Th-232	<0.07 - 0.72+/-0.57	1/4		
U-234	<0.2 - 98.0+/-4.0	4/5		
U-235	<0.08 - 0.14+/-0.1	1/4		
U-238	<0.1 - 3.2+/-0.04	3/4		

Note: * Metals expressed in mg/l; volatile organics expressed in ug/l;
radionuclides expressed in pCi/l
* Background concentrations are those obtained from the Pennsgrove
Water Supply Company

TABLE 24
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN PRIVATE GROUND WATER WELLS

Chemical	Reported		Background		New Jersey MCL
	Range	ND	Range	ND	
Arsenic	<0.001 - 0.006	4/6	<0.05	0/3	0.05
Cadmium	<0.001 - 0.003	2/15	<0.01	0/3	0.01
Chromium	0.005 - 0.013	6/6	<0.05	0/3	0.05
Copper	<0.020 - 0.253	3/6	<0.05	0/3	1.0
Lead	<0.001 - 0.117	10/15	<0.05	0/3	0.05
Sulfate	4 - 85	6/6	13 - 48	3/3	250
Chloride	9 - 49	6/6	13 - 260	3/3	250
Gross alpha	<1.0 - 1.6+/-1.3	1/7			15
Gross beta	<2.0 - 6.5+/-1.7	5/7			

Note: * Inorganics and MCLs expressed in mg/l; radionuclides expressed in pCi/l

ND = Number of Detections

MCL = Maximum Contaminant Level

TABLE 25
NSNJ, INC./NL INDUSTRIES, INC. SITE
COMPARISON OF WATER CONCENTRATIONS
TO DRINKING WATER STANDARDS

	Maximum Concentration	New Jersey Drinking Water Standard	Comment	Justification for Dropping
METALS (mg/l)				
Antimony	0.122			
Arsenic	18.2	0.05	over	
Beryllium	0.156			
Cadmium	1.01	0.01	over	
Chromium	4.340	0.05	over	
Copper	4.680	1.0	over	
Lead	6.290	0.05	over	
Mercury	0.0006	0.002	within	1 mtrx, within std
Nickel	2.48			
Selenium	0.004	0.01	within	
Silver	0.044	0.05	within	1 mtrx, within std
Thallium	0.003			
Zinc	9.69	5	over	
Chloride	150	250	within	2 mtrx, within std, below bkgd
Sulfate	24000	250	over	
VOLATILES (mg/l)				
1,3-Dichlorobenzene	0.001	0.600	within	within standard
1,1-Dichloroethane	0.074			
1,1-Dichloroethene	0.170	0.002	over	
Ethylbenzene	0.0005	0.680 G	within	within standard
Tetrachloroethene	0.180	0.001	over	
Toluene	0.0015	2.000 G	within	within standard
1,1,1-trichloroethane	4.700	0.026	over	
vinyl chloride	0.009	0.002	over	
xylene	0.0015	0.044	within	within standard
RADIOACTIVITY (pci/l)				
Gross alpha	570 +/- 180	15	over	no bkgd data, no known
Gross beta	580 +/- 170			source on-site
Total radium	100 +/- 10	5 M	over	"
Pb-210	5.6 +/- 3.8			"
K-40	14.0 +/- 1.0			"
Ra-226	1.42 +/- 0.69	5	within	"
Ra-228	1.8 +/- 0.6	5	within	"
Th-228	7.02 +/- 0.70			"
Th-230	44 +/- 11			"
Th-232	0.72 +/- 0.57			"
U-234	98.0 +/- 4.0			"
U-235	0.14 +/- 0.1			"
U-238	3.2 +/- 0.04			"

M = USEPA MCL; G = USEPA Maximum Contaminant Level Goal

TABLE 26
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN

	Soils (mg/kg)	Ground Water (mg/l)	Surface Water (mg/l)	Sediments (mg/kg)
METALS				
Antimony	0.6 - 110	<0.003 - 0.122	0.0795	<30.4 - 477.8
Arsenic	2.04 - 11.8	<0.001 - 18.2	0.0607	3.8 - 280.3
Beryllium	NA	0.003 - 0.156	NA	NA
Cadmium	<1 - 3.50	<0.001 - 1.01	0.0140	2.0 - 21.2
Chromium	5.93 - 19.2	0.001 - 4.340	0.0160	9.1 - 49.3
Copper	5.00 - 24.2	0.011 - 4.680	0.0390	33.4 - 187.2
Lead	2.91 - 12700	<0.001 - 6.290	0.0100 - 3.000	<5 - 59700.0
Nickel	NA	<0.04 - 2.48	NA	NA
Selenium	ND	<0.002 - 0.004	ND	0.5 - 2.7
Thallium	NA	<0.001 - 0.003	NA	NA
Zinc	15.8 - 57.2	0.018 - 9.69	0.1622	12.2 - 280.8
Sulfate	NA	<1 - 24000	9 - 1200	NA
VOLATILES				
1,1-Dichloroethane	NA	<0.0005 - 0.074	NA	NA
1,1-Dichloroethene	NA	<0.0005 - 0.170	NA	NA
Tetrachloroethene	NA	<0.0005 - 0.180	NA	NA
1,1,1-trichloroethane	NA	<0.0005 - 4.700	NA	NA
vinyl chloride	NA	<0.001 - 0.009	NA	NA

NA = Not Analyzed
ND = Not Detected

TABLE 27
MSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICAL RELEASE SOURCES

Receiving Medium	Release Mechanism	Release Source
Air	Fugitive dust	Wastes
Surface water	Surface runoff	Contaminated surface soil
Surface water	Ground water seepage	Contaminated ground water
Ground water	Leaching	Wastes
Ground water	Leaching	Contaminated soil
Ground water	Surface water seepage	Contaminated surface water
Soil	Leaching	Wastes
Soil	Surface runoff	Contaminated surface soil
Soil	Fugitive dust	Wastes
Soil	Tracking	Contaminated surface soil
Sediment	Surface runoff	Wastes
Sediment	Surface runoff	Contaminated surface soil
Biota	Uptake	Contaminated soil, surface water water, sediment

TABLE 28
NSNJ, INC./NL INDUSTRIES, INC. SITE
POTENTIAL MIGRATION PATHWAYS
AND EXPOSURE POINTS

Release Source	Release Mechanism	Transport Medium	Exposure Point
wastes	fugitive dust	air	on-site air
wastes	fugitive dust	air	off-site air
contaminated GW	GW seepage	SW	West Stream
contaminated GW	GW seepage	SW	East Stream
contaminated SW	SW flow	SW	Delaware River
contaminated soil	surface runoff	SW	Ponded water
contaminated soil	surface runoff	SW	West Stream
contaminated soil	surface runoff	SW	animals
wastes	leaching	GW	on-site wells
contaminated SW	SW seepage	GW	on-site wells
contaminated soil	leaching	GW	on-site wells
contaminated GW	GW seepage	GW	off-site wells
wastes	leaching	soil	on-site
wastes	fugitive dust	soil	on-site
wastes	fugitive dust	soil	off-site
contaminated soil	surface runoff	soil	on-site
contaminated soil	surface runoff	soil	crops
wastes	surface runoff	SW sediment	Ponded water
contaminated soil	surface runoff	SW sediments	Ponded water
SW sediments	SW flow	SW sediments	Delaware River
wastes			on-site

TABLE 29
NSNJ, INC./NL INDUSTRIES, INC. SITE
POTENTIAL EXPOSURE ROUTES
AND EXPOSURE PATHWAYS

Exposure Medium Exposure Route	Exposure Point	Current Exposures; Current Land Use	Future Exposures; Current Land Use	Future Exposures; Future Land Use
Air -----				
Inh	on-site	incomplete	complete	complete
Inh	off-site	incomplete	complete	complete
Surface Water -----				
Ing, derm	West Stream	incomplete	incomplete	incomplete
Ing, derm	East Stream	incomplete	incomplete	incomplete
Ing, derm, ffish	Delaware River	complete	complete	complete
Ing, derm	Ponded water	complete	complete	complete
Ground Water -----				
Ing, inh, derm	on-site wells	incomplete	incomplete	complete
Ing, inh, derm	private wells	incomplete	complete	complete
Soil -----				
Ing, derm	on-site	complete	complete	complete
Ing, derm	off-site	complete	complete	complete
Sediment -----				
Ing, derm	Ponded water	complete	complete	complete
Ing, derm	West Stream	incomplete	incomplete	incomplete
Ing, derm	Delaware River	incomplete	incomplete	incomplete
Wastes -----				
Ing, derm	on-site within fence	incomplete	complete	complete
Foodchain -----				
Ing	animals, crops	complete	complete	complete

Ing = ingestion, Inh = inhalation, Derm = dermal contact

TABLE 30
MSNJ, INC./NL INDUSTRIES, INC. SITE
COMPLETE EXPOSURE PATHWAYS

Potentially Exposed Population	Exposure Route/ Medium/ and Exposure Point	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Trespassers	INH/air/on-site	No	No data
On-Site Worker	INH/air/on-site	Yes	Workers would inhale site air
Off-Site Resident	INH/air/off-site	No	No data
Residents	DC, ING, FI/Delaware River	No	Large dilution factor
Trespassers, On-site Workers	DC/SW/site ponded water	Yes	Receptors may contact water which occasionally ponds on-site
Trespassers, On-Site Workers	ING/SW/site ponded water	No	Magnitude of risk is small
Residents	DC, ING, INH/GW/private wells	Yes	Local GW is used for potable water
Off-site Workers	ING/GW/downgradient wells	Yes	Local GW is used for potable water
Off-site Workers	DC/GW/downgradient wells	No	Magnitude of risk is small
Trespassers, On-Site Workers	ING, DC/soil/on-site	Yes	Receptors may contact site soil
Workers	ING, DC/soil/workplace	Yes	Workers may contact contaminated soil at the workplace
Off-Site Residents	ING, DC/soil/off-site residence	Yes	Residents may contact contaminated soils
Trespassers, On-Site Workers	ING, DC/sediment/ponded water	No	Site soil contains higher concentrations than ponded areas; soil exposures are quantified
Residents	ING/game animals & crops	No	Magnitude of risk is small

DC = direct contact, ING = ingestion, INH = inhalation, FI = fish ingestion
GW = ground water, SW = surface water

TABLE 31
NSMJ, INC./NL INDUSTRIES, INC. SITE
MODELED AIR CONCENTRATIONS

Chemical	Concentration in air (ug/m ³)
Antimony	2.51E-06
Arsenic	3.08E-07
Cadmium	9.14E-08
Chromium	4.94E-07
Copper	6.32E-07
Lead	1.73E-04
Zinc	1.47E-06

TABLE 32
MSNJ, INC./NL INDUSTRIES, INC. SITE
CALCULATION OF GROUND WATER EXPOSURE CONCENTRATIONS

Sample #	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Se	SO4	Th	Zn	1,1-DCA	1,1-DCE	PCE	111-TCA	VC
1R	8/89			0.003		0.005				2300							
3R	8/88	0.03	0.001	0.012	0.002	0.020	0.010		0.02	147							
	8/89			0.008		0.007				770							
4R	8/88	0.003	0.001	0.047	0.013	0.020	0.031		0.02	553							
	8/89			0.015		0.011				190							
5R	8/88	0.03	0.001	0.001	0.012	0.020	0.01		0.02	283							
	8/89			0.001		0.013				180							
6	8/89			0.002		0.01				240							
7	8/88	0.03	0.001	0.031	0.014	0.113	0.008		0.02	647							
	8/89			0.023		0.012	0.005			490							
9R2	8/88	0.003	0.001	0.001	0.003	0.020	0.003		0.002	3							
	8/89			0.001		0.002				2							
10	8/88	0.003	0.001	0.045	0.010	0.028	0.012		0.02	284							
	8/89			0.041		0.007	0.063			170							
11	8/88	0.003	0.030	0.003	0.134	0.005	0.042	0.006	0.14	0.02	2760	0.001	0.297	0.074	0.170	0.180	4.700
	8/89		0.003	0.213		0.005				1800			0.050	0.160	0.057	1.900	0.005
	10/89																
12	8/88	0.03	0.002	0.001	0.001	0.020	0.027		0.002	4							
	8/89			0.001		0.001				1							
13	10/89		0.001	0.001	0.003	0.008				3							
14	10/89		0.001	0.001	0.005	0.001				30							
15	10/89		0.001	0.001	0.004	0.001				22							
16	10/89		0.001	0.001	0.007	0.005				31							
17	10/89		0.006	0.001	0.046	0.008				13							
18	10/89												0.0005	0.0005	0.0005	0.0005	0.0005
BR	8/88	0.003	0.001	0.015	0.002	0.039	0.018		0.02	1100							
	8/89			0.001		0.005				89							
	10/89												0.0005	0.0005	0.0005	0.0005	0.009
CR2	8/88	0.003	0.001	0.001	0.010	0.020	0.028		0.002	4							
	8/89			0.001		0.006				3							
HD	8/88	0.005	0.003	0.064	0.013	0.040	0.079		0.02	1140							
	8/89	0.03		0.379		0.009				650							
HS	8/88	0.122	0.002	0.010	0.003	0.024	6.290		0.002	84							
	8/89	0.092		0.0063		4.4				69							
ID	8/88	0.003	0.001	0.003	0.004	0.001	0.020	0.026	0.04	0.02	54	0.001	0.088				
	8/89			0.003		0.011				65							
JD	8/88	0.03	0.001	0.007	0.103	0.027	0.143	0.014	0.099	0.02	741	0.001	0.603				
	8/89			0.049	0.009	0.062	0.003	0.064		270							
KD	8/88	0.03	0.01	0.291	0.246	0.513	0.061		0.02	8460							
	8/89			0.113	0.081	0.152	0.019			2700							
KS	8/88	0.03	0.01	0.173	0.060	0.219	3.130		0.02	3070							
	8/89			0.079	0.016	0.092	2.400			1300							
LD	8/88	0.03	0.002	0.002	0.011	0.020	0.044		0.02	170							

TABLE 32
NSNJ, INC./NL INDUSTRIES, INC. SITE
CALCULATION OF GROUND WATER EXPOSURE CONCENTRATIONS

Sample #	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Se	SO4	Th	Zn	1,1-DCA	1,1-DCE	PCE	111-TCA	VC
	8/89			0.002		0.024				41							
MD	8/88	0.003	0.011	0.008	0.005	0.020	0.002		0.02	1730							
	8/89		0.001	0.008		0.005				570			0.0002	0.00025	0.0002	0.0002	0.0002
MS	8/88	0.003	0.001	0.011	0.004	0.020	0.198		0.02	321							
	8/89			0.016		0.219											
ND	8/88	0.03	0.001	0.008	0.012	0.068	0.064		0.02	1580							
	8/89			0.006		0.014				2000							
NS	8/88	0.03	0.001	0.009	0.013	0.020	0.045		0.02	367							
	8/89			0.004		0.01				200							
OD	8/88	0.03	0.002	0.002	0.046	0.020	0.030		0.02	5630							
	8/89			0.001	0.121	0.001				980							
PD	8/88	0.003	0.017	0.001	0.002	0.020	0.039		0.02	1140							
	8/89		0.003	0.001		0.001				740							
QS	8/88	0.003	0.002	0.003	0.007	0.003	0.020	0.090	0.04	0.002	328	0.001	0.018				
RD	8/88	0.003	0.001	0.001	0.003	0.020	0.004		0.004	46							
	8/89			0.001		0.001				32							
RS	8/88			0.001		0.002				12							
SS	8/88	0.03	0.020	0.119	0.021	0.011	0.086		0.02	1090							
	8/89		0.005	0.015	0.010	0.001				940							
Arithmetic mean	0.023	0.004	0.004	0.036	0.023	0.062	0.298	0.074	0.016	839	0.001	0.252	0.025	0.066	0.048	1.320	0.004
Std. dev. (SD)	0.027	0.006	0.002	0.072	0.045	0.097	1.084	0.035	0.007	1424	0.000	0.227	0.031	0.081	0.070	1.843	0.004
Arith. Mean + 2 SD	0.077	0.017	0.007	0.180	0.113	0.256	2.467	0.145	0.031	3687	0.001	0.706	0.087	0.228	0.187	5.006	0.011
Maximum Conc.	0.122	0.030	0.007	0.379	0.246	0.513	6.290	0.140	0.020	8460	0.001	0.603	0.074	0.170	0.180	4.700	0.009
Conc. to be used	0.077	0.017	0.007	0.180	0.113	0.256	2.467	0.140	0.020	3687	0.001	0.603	0.074	0.170	0.180	4.700	0.009

Note: Concentrations expressed in mg/l

If the chemical was not detected, one-half the detection limit is used

A blank space indicates that the sample was not analyzed for that chemical

TABLE 33
 NSNJ, INC./NL INDUSTRIES, INC. SITE
 CALCULATION OF SURFACE WATER
 EXPOSURE CONCENTRATIONS IN ON-SITE PONDED WATER

Sample #	Lead	Sulfate
408	3	
409	1.98	
WS-16	0.244	140
WS-17	0.418	140
Arithmetic mean	1	140
Std. dev. (SD)	1	0
Arith. Mean + 2 SD	4	140
Maximum Conc.	3	140
Conc. to be used	3	140

Note: concentrations expressed in mg/l

TABLE 34
INSNJ, INC./NL INDUSTRIES, INC. SITE
CALCULATION OF SOIL EXPOSURE CONCENTRATIONS
(RESIDENTIAL AREAS)

Sample #	Lead	Arsenic	Chromium	Copper	Zinc
9 (0-3)	48.4				
9 (3-6)	23.1				
10 (0-3)	26.6				
10 (3-6)	27.8				
11 (0-3)	57.9				
11 (3-6)	43.3				
12 (0-3)	72.9				
12 (3-6)	28.4				
15 (0-3)	32.6	9.63	6.26	8.79	38.1
15 (3-6)	33.1				
16 (0-3)	130				
16 (3-6)	21				
19 (0-3)	45.3				
19 (3-6)	29.5				
25 (0-3)	307				
25 (3-6)	317				
25 (6-12)	244				
27 (0-3)	206				
27 (3-6)	226				
27 (6-12)	142				
28 (0-3)	275				
28 (3-6)	106				
Arithmetic mean	111	9.63	6.26	8.79	38.1
Std. dev. (SD)	100	0	0	0	0
Arith. Mean + 2 SD	312	9.63	6.26	8.79	38.1
Maximum Conc.	317	9.63	6.26	8.79	38.1
Conc. to be used	312	9.63	6.26	8.79	38.1

Note: concentrations expressed in mg/kg

TABLE 35
NSNJ, INC./NL INDUSTRIES, INC. SITE
CALCULATION OF SOIL EXPOSURE CONCENTRATIONS
(INDUSTRIAL AREAS)

Sample #	Lead	Arsenic	Chromium	Copper	Zinc
2 (0-3)	58.6				
2 (3-6)	24.6				
3 (0-3)	35.7	1.65	7.04	3.25	21.0
3 (3-6)	29.7				
4 (0-3)	89	3.03	10.5	4.34	22.0
4 (3-6)	23.1				
5 (0-3)	55.4				
5 (3-6)	13.4				
21 (0-3)	41.2				
21 (3-6)	40.3				
22 (0-3)	46.3	6.31	5.86	5.60	14.8
22 (3-6)	50.8				
24 (0-3)	367				
24 (3-6)	132				
45 (0-3)	108				
45 (3-6)	37				
46 (0-3)	87				
46 (3-6)	25				
47 (0-3)	457				
47 (3-6)	382				
47 (6-12)	55.4				
Arithmetic mean	103	3.66	7.80	4.40	19.3
Std. dev. (SD)	126	1.95	1.97	0.96	3.2
Arith. Mean + 2 SD	355	7.57	11.74	6.32	25.6
Maximum Conc.	457	6.31	10.5	5.60	22.0
Conc. to be used	355	6.31	10.50	5.60	22.0

Note: concentrations expressed in mg/kg

TABLE 36
NSNJ, INC./NL INDUSTRIES, INC. SITE
CALCULATION OF SOIL EXPOSURE CONCENTRATIONS
(ON-SITE SOIL)

Sample #	Lead	Antimony	Arsenic	Cadmium	Chromium	Copper	Zinc
Accessible Soil *							

209 (0-3")	634						
211 (0-3")	7500						
214 (0-3")	572						
221 (0-3")	1580	25	11.6	3.32	8.29	24.2	57.2
Arithmetic mean	2572	25	11.6	3.32	8.29	24.2	57.2
Std. dev. (SD)	2873	0	0	0	0	0	0
Arith. Mean + 2 SD	8318	25	11.6	3.32	8.29	24.2	57.2
Maximum Conc.	7500	25	11.6	3.32	8.29	24.2	57.2
Conc. to be used	7500	25	11.6	3.32	8.29	24.2	57.2
All Soil (Surface/Subsurface)							

212 (0-3")		10	6.68	0.5	11.3	15.1	23.3
203 (0-3")		10	4.45	0.5	19.2	5.32	29.6
220 (0-3")		110	11.8	3.50	9.38	16.4	30.1
221 (0-3")		25	11.6	3.32	8.29	24.2	57.2
204 (0-3")		10	3.90	0.5	7.47	5.00	17.0
207 (0-3")		10	2.72	0.5	5.93	6.98	15.8
217 (18-24")		0.6	2.78				
201 (0-3")	21						
201 (3-6")	12						
202 (0-3")	19						
202 (3-6")	15						
203 (0-3")	25						
203 (3-6")	16						
204 (0-3")	153						
204 (3-6")	45						
205 (0-3")	29						
205 (3-6")	18						
206 (0-3")	60						
206 (3-6")	30						
207 (0-3")	100						
207 (3-6")	26						

TABLE 36
MSNJ, INC./NL INDUSTRIES, INC. SITE
CALCULATION OF SOIL EXPOSURE CONCENTRATIONS
(ON-SITE SOIL)

Sample #	Lead	Antimony	Arsenic	Cadmium	Chromium	Copper	Zinc
208 (0-3")	22						
208 (3-6")	16						
209 (0-3")	634						
209 (3-6")	756						
209 (6-12")	131						
209 (12-18")	83						
210 (0-3")	33						
210 (3-6")	25						
211 (0-3")	7500						
211 (3-6")	5910						
211 (6-12")	5320						
211 (12-18")	1820						
211 (18-24")	22.3						
211 (24-30")	45.3						
212 (0-3")	333						
212 (3-6")	172						
212 (6-12")	68						
212 (12-18")	34						
213 (0-3")	1800						
213 (3-6")	2040						
213 (6-12")	1040						
213 (12-18")	541						
213 (18-24")	891						
214 (0-3")	572						
214 (3-6")	120						
215 (0-3")	1730						
215 (3-6")	383						
215 (6-12")	39						
215 (12-18")	28						
216 (0-3")	2080						
216 (3-6")	165						
217 (0-3")	12700						
217 (3-6")	12300						
217 (6-12")	6880						
217 (12-18")	2940						
217 (18-24")	231						
217 (24-30")	302						
218 (0-3")	9340						
218 (3-6")	1620						
218 (6-12")	4370						
218 (12-18")	954						

TABLE 36
NSNJ, INC./NL INDUSTRIES, INC. SITE
CALCULATION OF SOIL EXPOSURE CONCENTRATIONS
(ON-SITE SOIL)

Sample #	Lead	Antimony	Arsenic	Cadmium	Chromium	Copper	Zinc
218 (18-24")	2.91						
218 (24-30")	6.01						
219 (0-3")	740						
219 (3-6")	99						
220 (0-3")	3590						
220 (3-6")	2840						
220 (6-12")	3220						
220 (12-18")	792						
220 (18-24")	15.9						
220 (24-30")	51.5						
221 (0-3")	1580						
221 (3-6")	793						
221 (6-12")	117						
222 (12-18")	49						
222 (0-3")	4610						
222 (3-6")	226						
222 (6-12")	84						
222 (12-18")	152						
223 (0-3")	1220						
223 (3-6")	170						
223 (6-12")	56						
223 (12-18")	20						
Arithmetic mean	1390	25	6.28	1.47	10.26	12.17	28.8
Std. dev. (SD)	2623	35	3.64	1.37	4.32	7.03	13.8
Arith. Mean + 2 SD	6636	96	13.56	4.22	18.91	26.23	56.5
Maximum Conc.	12700	110	11.8	3.50	19.2	24.2	57.2
Conc. to be used	6636	96	11.8	3.50	18.91	24.2	56.5

Note: Concentrations expressed in mg/kg

* = Accessible site soil is that which an on-site trespasser may easily contact

TABLE 37
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUMMARY OF EXPOSURE CONCENTRATIONS

Chemical	ING, DERM		Off-Site	Off-Site	On-site	On-site	On-site	Well 2R2	Well SD
	INH	DERM	Residential	Industrial	Trespasser	Worker	Worker		
	of GW	of SW	ING, DERM	ING, DERM	ING, DERM	ING, DERM	INH	ING, DERM	ING, DERM
	(mg/l)	(mg/l)	of soil	of soil	of soil	of soil	of air	of GW	of GW
	(mg/l)	(mg/l)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/m ³)	(mg/l)	(mg/l)
Antimony	0.08				25	96	2.51E-06		
Arsenic	0.017		9.63	6.31	11.6	11.8	3.08E-07	18.2	
Beryllium	0.007								0.156
Cadmium	0.180				3.32	3.50	9.14E-08	0.01	1.01
Chromium	0.113		6.26	10.50	8.29	18.91	4.94E-07	0.008	4.340
Copper	0.256		8.79	5.60	24.2	24.2	6.32E-07		4.680
Lead	2.467	3	312	355	7500	6636	1.73E-04	0.004	0.294
Nickel	0.14								1.93
Selenium	0.02								
Sulfate	3687	140						6100	24000
Thallium	0.001								0.003
Tin									
Zinc	0.603		38.1	22.0	57.2	56.5	1.47E-06		8.64
1,1-Dichloroethane	0.074								
1,1-Dichloroethene	0.170								
Tetrachloroethene	0.180								
1,1,1-Trichloroethane	4.700								
Vinyl Chloride	0.009								

DERM= dermal absorption; ING = ingestion; INH = inhalation

GW = ground water, SW = surface water

Notes: Air, GW, SW, and soil concentrations obtained from Tables 31-36

TABLE 38
NSNJ, INC./NL INDUSTRIES, INC. SITE
INHALATION OF SITE AIR FOR FUTURE INDUSTRIAL SITE USE

Chemical	CA (ng/m ³)	IR (m ³ /hr)	ET (hr/dy)	EF (dys/yr)	ED (yrs)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Antimony	2.51E-06	3.0	9	260	30	70	30	6.90E-07		
Arsenic	3.08E-07	3.0	9	260	30	70	30	8.46E-08	70	3.63E-08
Cadmium	9.14E-08	3.0	9	260	30	70	30	2.51E-08	70	1.08E-08
Chromium	4.94E-07	3.0	9	260	30	70	30	1.36E-07	70	5.82E-08
Copper	6.32E-07	3.0	9	260	30	70	30	1.74E-07		
Lead	1.73E-04	3.0	9	260	30	70	30	4.75E-05	70	2.04E-05
Zinc	1.47E-06	3.0	9	260	30	70	30	4.04E-07		

CA = contaminant concentration in air; IR = inhalation rate;
ET = exposure time; EF = exposure frequency; ED = exposure duration;
BW = body weight; AT = averaging time

$$\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}} = \text{Intake (mg/kg-day)}$$

TABLE 39
NSNJ, INC./NL INDUSTRIES, INC. SITE
INGESTION OF CHEMICALS IN DRINKING WATER

Chemical	CW (mg/l)	IR (l/day)	EF (dy/yr)	ED (years)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
SITE-WIDE GROUND WATER QUALITY									
Adult Resident									
Antimony	0.08	2	365	30	70	30	2.286E-03	-	-
Arsenic	0.017	2	365	30	70	30	4.9E-04	70	2.1E-04
Beryllium	0.007	2	365	30	70	30	2.000E-04	70	8.571E-05
Cadmium	0.180	2	365	30	70	30	5.14E-03	-	-
Chromium	0.113	2	365	30	70	30	3.229E-03	-	-
Copper	0.256	2	365	30	70	30	7.314E-03	-	-
Lead	2.467	2	365	30	70	30	7.05E-02	70	3.02E-02
Nickel	0.14	2	365	30	70	30	4.00E-03	-	-
Selenium	0.02	2	365	30	70	30	5.714E-04	-	-
Sulfate	3687	2	365	30	70	30	105	-	-
Thallium	0.001	2	365	30	70	30	2.857E-05	-	-
Zinc	0.603	2	365	30	70	30	1.72E-02	-	-
1,1-Dichloroethane	0.074	2	365	30	70	30	2.114E-03	70	9.061E-04
1,1-Dichloroethene	0.170	2	365	30	70	30	4.857E-03	70	2.082E-03
Tetrachloroethene	0.180	2	365	30	70	30	5.143E-03	70	2.204E-03
1,1,1-Trichloroethane	4.700	2	365	30	70	30	1.343E-01	-	-
Vinyl chloride	0.009	2	365	30	70	30	2.571E-04	70	1.102E-04
Child Resident (Ages 10-12)									
Antimony	0.08	2	365	3	36	3	4.444E-03	-	-
Arsenic	0.017	2	365	3	36	3	9.4E-04	70	4.0E-05
Beryllium	0.007	2	365	3	36	3	3.889E-04	70	1.667E-05
Cadmium	0.180	2	365	3	36	3	1.00E-02	-	-
Chromium	0.113	2	365	3	36	3	6.278E-03	-	-
Copper	0.256	2	365	3	36	3	1.422E-02	-	-
Lead	2.467	2	365	3	36	3	1.37E-01	70	5.87E-03
Nickel	0.14	2	365	3	36	3	7.78E-03	-	-
Selenium	0.02	2	365	3	36	3	1.111E-03	-	-
Sulfate	3687	2	365	3	36	3	205	-	-
Thallium	0.001	2	365	3	36	3	5.556E-05	-	-
Zinc	0.603	2	365	3	36	3	3.35E-02	-	-
1,1-Dichloroethane	0.074	2	365	3	36	3	4.111E-03	70	1.762E-04
1,1-Dichloroethene	0.170	2	365	3	36	3	9.444E-03	70	4.048E-04
Tetrachloroethene	0.180	2	365	3	36	3	1.000E-02	70	4.286E-04
1,1,1-Trichloroethane	4.700	2	365	3	36	3	2.611E-01	-	-
Vinyl chloride	0.009	2	365	3	36	3	5.000E-04	70	2.143E-05

TABLE 39
NSNJ, INC./NL INDUSTRIES, INC. SITE
INGESTION OF CHEMICALS IN DRINKING WATER

Chemical	CW (mg/l)	IR (l/day)	EF (dy/yr)	ED (years)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Off-site Worker									
Antimony	0.08	1	260	30	70	30	8.141E-04	-	-
Arsenic	0.017	1	260	30	70	30	1.7E-04	70	7.4E-05
Beryllium	0.007	1	260	30	70	30	7.123E-05	70	3.053E-05
Cadmium	0.180	1	260	30	70	30	1.83E-03	-	-
Chromium	0.113	1	260	30	70	30	1.150E-03	-	-
Copper	0.256	1	260	30	70	30	2.605E-03	-	-
Lead	2.467	1	260	30	70	30	2.51E-02	70	1.08E-02
Nickel	0.14	1	260	30	70	30	1.42E-03	-	-
Selenium	0.02	1	260	30	70	30	2.035E-04	-	-
Sulfate	3687	1	260	30	70	30	38	-	-
Thallium	0.001	1	260	30	70	30	1.018E-05	-	-
Zinc	0.603	1	260	30	70	30	6.14E-03	-	-
1,1-Dichloroethane	0.074	1	260	30	70	30	7.530E-04	70	3.227E-04
1,1-Dichloroethene	0.170	1	260	30	70	30	1.730E-03	70	7.414E-04
Tetrachloroethene	0.180	1	260	30	70	30	1.832E-03	70	7.850E-04
1,1,1-Trichloroethane	4.700	1	260	30	70	30	4.783E-02	-	-
Vinyl chloride	0.009	1	260	30	70	30	9.159E-05	70	3.925E-05
WELL 2R2 WATER QUALITY									
Adult Resident									
Arsenic	18.2	2	365	30	70	30	5.2E-01	70	2.2E-01
Cadmium	0.01	2	365	30	70	30	2.86E-04	-	-
Chromium	0.008	2	365	30	70	30	2.286E-04	-	-
Lead	0.004	2	365	30	70	30	1.143E-04	70	4.898E-05
Sulfate	6100	2	365	30	70	30	174	-	-
Child Resident (Ages 10-12)									
Arsenic	18.2	2	365	3	36	3	1.0E+00	70	4.3E-02
Cadmium	0.01	2	365	3	36	3	5.56E-04	-	-
Chromium	0.008	2	365	3	36	3	4.444E-04	-	-

TABLE 39
NSNJ, INC./NL INDUSTRIES, INC. SITE
INGESTION OF CHEMICALS IN DRINKING WATER

Chemical	CU (mg/l)	IR (l/day)	EF (dy/yr)	ED (years)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Lead	0.004	2	365	3	36	3	2.222E-04	70	9.524E-06
Sulfate	6100	2	365	3	36	3	339	-	-
Off-site Worker									
Arsenic	18.2	1	260	30	70	30	1.852E-01	70	7.937E-02
Cadmium	0.01	1	260	30	70	30	1.018E-04	-	-
Chromium	0.008	1	260	30	70	30	8.141E-05	-	-
Lead	0.004	1	260	30	70	30	4.070E-05	70	1.744E-05
Sulfate	6100	1	260	30	70	30	6.207E+01	-	-
=====									
WELL SD WATER QUALITY									
Adult Resident									
Beryllium	0.156	2	365	30	70	30	4.457E-03	70	1.910E-03
Cadmium	1.01	2	365	30	70	30	2.89E-02	-	-
Chromium	4.340	2	365	30	70	30	1.240E-01	-	-
Copper	4.680	2	365	30	70	30	1.337E-01	-	-
Lead	0.294	2	365	30	70	30	8.400E-03	70	3.600E-03
Nickel	1.93	2	365	30	70	30	5.51E-02	-	-
Sulfate	24000	2	365	30	70	30	686	-	-
Thallium	0.003	2	365	30	70	30	8.571E-05	-	-
Zinc	8.64	2	365	30	70	30	2.47E-01	-	-
Child Resident (Ages 10-12)									
Beryllium	0.156	2	365	3	36	3	8.667E-03	70	3.714E-04
Cadmium	1.01	2	365	3	36	3	5.61E-02	-	-
Chromium	4.340	2	365	3	36	3	2.411E-01	-	-
Copper	4.680	2	365	3	36	3	2.600E-01	-	-
Lead	0.294	2	365	3	36	3	1.633E-02	70	7.000E-04
Nickel	1.93	2	365	3	36	3	1.07E-01	-	-
Sulfate	24000	2	365	3	36	3	1333	-	-
Thallium	0.003	2	365	3	36	3	1.667E-04	-	-
Zinc	8.64	2	365	3	36	3	4.80E-01	-	-

TABLE 39
NSNJ, INC./NL INDUSTRIES, INC. SITE
INGESTION OF CHEMICALS IN DRINKING WATER

Chemical	CW (mg/l)	IR (l/day)	EF (dy/yr)	ED (years)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Off-site Worker									
Beryllium	0.156	1	260	30	70	30	1.587E-03	70	6.803E-04
Cadmium	1.01	1	260	30	70	30	1.028E-02	-	-
Chromium	4.340	1	260	30	70	30	4.416E-02	-	-
Copper	4.680	1	260	30	70	30	4.762E-02	-	-
Lead	0.294	1	260	30	70	30	2.992E-03	70	1.282E-03
Nickel	1.93	1	260	30	70	30	1.964E-02	-	-
Sulfate	24000	1	260	30	70	30	2.442E+02	-	-
Thallium	0.003	1	260	30	70	30	3.053E-05	-	-
Zinc	8.64	1	260	30	70	30	8.792E-02	-	-

CW = chemical concentration in water; IR = ingestion rate; EF = exposure frequency
ED = exposure duration; BW = body weight; AT = averaging time

$$\frac{CW \times IR \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}} = \text{Intake (mg/kg-day)}$$

TABLE 40
NSNJ, INC./NL INDUSTRIES, INC. SITE
DERMAL CONTACT WITH CHEMICALS IN GROUND WATER

Chemical	CW (mg/l)	SA (cm2)	PC (cm/hr)	ET (hr/dy)	EF (dy/yr)	ED (years)	CF (l/cm3)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Adult Resident												
Antimony	0.08	19400	0.0008	0.25	365	30	0.001	70	30	4.43E-06	-	-
Arsenic	0.017	19400	0.0008	0.25	365	30	0.001	70	30	9.42E-07	70	4.0E-07
Beryllium	0.007	19400	0.0008	0.25	365	30	0.001	70	30	3.88E-07	70	1.66E-07
Cadmium	0.180	19400	0.0008	0.25	365	30	0.001	70	30	9.98E-06	-	-
Chromium	0.113	19400	0.0008	0.25	365	30	0.001	70	30	6.26E-06	-	-
Copper	0.256	19400	0.0008	0.25	365	30	0.001	70	30	1.42E-05	-	-
Lead	2.467	19400	0.0008	0.25	365	30	0.001	70	30	1.37E-04	70	5.86E-05
Nickel	0.14	19400	0.0008	0.25	365	30	0.001	70	30	7.76E-06	-	-
Selenium	0.02	19400	0.0008	0.25	365	30	0.001	70	30	1.11E-06	-	-
Sulfate	3687	19400	0.0008	0.25	365	30	0.001	70	30	2E-01	-	-
Thallium	0.001	19400	0.0008	0.25	365	30	0.001	70	30	5.54E-08	-	-
Zinc	0.603	19400	0.0008	0.25	365	30	0.001	70	30	3.34E-05	-	-
1,1-Dichloroethane	0.074	19400	0.0008	0.25	365	30	0.001	70	30	4.10E-06	70	1.76E-06
1,1-Dichloroethene	0.170	19400	0.0008	0.25	365	30	0.001	70	30	9.42E-06	70	4.04E-06
Tetrachloroethene	0.180	19400	0.0008	0.25	365	30	0.001	70	30	9.98E-06	70	4.28E-06
1,1,1-Trichloroethane	4.700	19400	0.0008	0.25	365	30	0.001	70	30	2.61E-04	-	-
Vinyl chloride	0.009	19400	0.0008	0.25	365	30	0.001	70	30	4.99E-07	70	2.14E-07
Adult Resident - Well ZR2												
Arsenic	18.2	19400	0.0008	0.25	365	30	0.001	70	30	1.01E-03	70	4.32E-04
Cadmium	0.01	19400	0.0008	0.25	365	30	0.001	70	30	5.54E-07	-	-
Chromium	0.008	19400	0.0008	0.25	365	30	0.001	70	30	4.43E-07	-	-
Lead	0.004	19400	0.0008	0.25	365	30	0.001	70	30	2.22E-07	70	9.50E-08
Sulfate	6100	19400	0.0008	0.25	365	30	0.001	70	30	3.38E-01	-	-
Adult Resident - Well SD												
Beryllium	0.156	19400	0.0008	0.25	365	30	0.001	70	30	8.65E-06	70	3.71E-06
Cadmium	1.01	19400	0.0008	0.25	365	30	0.001	70	30	5.60E-05	-	-
Chromium	4.340	19400	0.0008	0.25	365	30	0.001	70	30	2.41E-04	-	-
Copper	4.680	19400	0.0008	0.25	365	30	0.001	70	30	2.59E-04	-	-
Lead	0.294	19400	0.0008	0.25	365	30	0.001	70	30	1.63E-05	70	6.98E-06
Nickel	1.93	19400	0.0008	0.25	365	30	0.001	70	30	1.07E-04	-	-
Sulfate	24000	19400	0.0008	0.25	365	30	0.001	70	30	1.33E+00	-	-
Thallium	0.003	19400	0.0008	0.25	365	30	0.001	70	30	1.66E-07	-	-
Zinc	8.64	19400	0.0008	0.25	365	30	0.001	70	30	4.79E-04	-	-

TABLE 40
NSNJ, INC./NL INDUSTRIES, INC. SITE
DERMAL CONTACT WITH CHEMICALS IN GROUND WATER

Chemical	CW (mg/l)	SA (cm2)	PC (cm/hr)	ET (hr/dy)	EF (dy/yr)	ED (years)	CF (l/cm3)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Child Resident (Ages 10-12)												
Antimony	0.08	11600	0.0008	0.25	365	3	0.001	36	3	5.16E-06	-	-
Arsenic	0.017	11600	0.0008	0.25	365	3	0.001	36	3	1.10E-06	70	4.70E-08
Beryllium	0.007	11600	0.0008	0.25	365	3	0.001	36	3	4.51E-07	70	1.93E-08
Cadmium	0.180	11600	0.0008	0.25	365	3	0.001	36	3	1.16E-05	-	-
Chromium	0.113	11600	0.0008	0.25	365	3	0.001	36	3	7.28E-06	-	-
Copper	0.256	11600	0.0008	0.25	365	3	0.001	36	3	1.65E-05	-	-
Lead	2.467	11600	0.0008	0.25	365	3	0.001	36	3	1.59E-04	70	6.81E-06
Nickel	0.14	11600	0.0008	0.25	365	3	0.001	36	3	9.02E-06	-	-
Selenium	0.02	11600	0.0008	0.25	365	3	0.001	36	3	1.29E-06	-	-
Sulfate	3687	11600	0.0008	0.25	365	3	0.001	36	3	2E-01	-	-
Thallium	0.001	11600	0.0008	0.25	365	3	0.001	36	3	6.44E-08	-	-
Zinc	0.603	11600	0.0008	0.25	365	3	0.001	36	3	3.89E-05	-	-
1,1-Dichloroethane	0.074	11600	0.0008	0.25	365	3	0.001	36	3	4.77E-06	70	2.04E-07
1,1-Dichloroethene	0.170	11600	0.0008	0.25	365	3	0.001	36	3	1.10E-05	70	4.70E-07
Tetrachloroethene	0.180	11600	0.0008	0.25	365	3	0.001	36	3	1.16E-05	70	4.97E-07
1,1,1-Trichloroethane	4.700	11600	0.0008	0.25	365	3	0.001	36	3	3.03E-04	-	-
Vinyl chloride	0.009	11600	0.0008	0.25	365	3	0.001	36	3	5.80E-07	70	2.49E-08
Child Resident (Ages 10-12) - Well 2R2												
Arsenic	18.2	11600	0.0008	0.25	365	3	0.001	36	3	1.17E-03	70	5.03E-05
Cadmium	0.01	11600	0.0008	0.25	365	3	0.001	36	3	6.44E-07	-	-
Chromium	0.008	11600	0.0008	0.25	365	3	0.001	36	3	5.16E-07	-	-
Lead	0.004	11600	0.0008	0.25	365	3	0.001	36	3	2.58E-07	70	1.10E-08
Sulfate	6100	11600	0.0008	0.25	365	3	0.001	36	3	3.93E-01	-	-
Child Resident (Ages 10-12) - Well SD												
Beryllium	0.156	11600	0.0008	0.25	365	3	0.001	36	3	1.01E-05	70	4.31E-07
Cadmium	1.01	11600	0.0008	0.25	365	3	0.001	36	3	6.51E-05	-	-
Chromium	4.340	11600	0.0008	0.25	365	3	0.001	36	3	2.80E-04	-	-
Copper	4.680	11600	0.0008	0.25	365	3	0.001	36	3	3.02E-04	-	-
Lead	0.294	11600	0.0008	0.25	365	3	0.001	36	3	1.89E-05	70	8.12E-07
Nickel	1.93	11600	0.0008	0.25	365	3	0.001	36	3	1.24E-04	-	-
Sulfate	24000	11600	0.0008	0.25	365	3	0.001	36	3	1.55E+00	-	-

TABLE 40
NSNJ, INC./NL INDUSTRIES, INC. SITE
DERMAL CONTACT WITH CHEMICALS IN GROUND WATER

Chemical	CW (mg/l)	SA (cm ²)	PC (cm/hr)	ET (hr/dy)	EF (dy/yr)	ED (years)	CF (l/cm ³)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Thallium	0.003	11600	0.0008	0.25	365	3	0.001	36	3	1.93E-07	-	-
Zinc	8.64	11600	0.0008	0.25	365	3	0.001	36	3	5.57E-04	-	-

CW = chemical concentration in water; SA = skin surface area; PC = permeability constant; ET = exposure time
EF = exposure frequency; ED = exposure duration; CF = volumetric conversion factor; BW = body weight; AT = averaging time

$$\frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT \times 365 \text{ days/yr}} = \text{Intake (mg/kg-day)}$$

TABLE 41
NSNJ, INC./NL INDUSTRIES, INC. SITE
DERMAL CONTACT WITH CHEMICALS IN SURFACE WATER

Chemical	CW (mg/l)	SA (cm ²)	PC (cm/hr)	ET (hr/dy)	EF (dy/yr)	ED (years)	CF (l/cm ³)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Child Trespasser												
Lead	3	2040	0.0008	0.5	4	3	0.001	36	3	7.5E-07	70	3.2E-08
Sulfate	140	2040	0.0008	0.5	4	3	0.001	36	3	3.5E-05	-	-
Worker												
Lead	3	3120	0.0008	0.5	52	30	0.001	70	30	7.6E-06	70	3.3E-06
Sulfate	140	3120	0.0008	0.5	52	30	0.001	70	30	3.6E-04	-	-

CW = chemical concentration in water

SA = skin surface area

PC = permeability constant

ET = exposure time

EF = exposure frequency

ED = exposure duration

CF = volumetric conversion factor

BW = body weight

AT = averaging time

$$\frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT \times 365 \text{ days/yr}} = \text{Intake (mg/kg-day)}$$

TABLE 42
NSNJ, INC./NL INDUSTRIES, INC. SITE
INGESTION OF CHEMICALS IN SOIL

Chemical	CS (mg/kg)	IR (mg/day)	CF (kg/mg)	FI	EF (dy/yr)	ED (years)	BW (kg)	AT (yrs)	Intake	AT (years)	Intake
Adult Resident (Off-site)											
Arsenic	9.63	100	1.00E-06	1	52	30	70	30	1.96E-06	70	8.40E-07
Chromium	6.26	100	1.00E-06	1	52	30	70	30	1.27E-06	-	-
Copper	8.79	100	1.00E-06	1	52	30	70	30	1.79E-06	-	-
Lead	312	100	1.00E-06	1	52	30	70	30	6E-05	70	3E-05
Zinc	38.1	100	1.00E-06	1	52	30	70	30	7.8E-06	70	-
Child Resident (Off-site; Ages 10-12)											
Arsenic	9.63	100	1.00E-06	1	152	3	36	3	1.11E-05	70	4.77E-07
Chromium	6.26	100	1.00E-06	1	152	3	36	3	7.24E-06	-	-
Copper	8.79	100	1.00E-06	1	152	3	36	3	1.02E-05	-	-
Lead	312	100	1.00E-06	1	152	3	36	3	4E-04	70	2E-05
Zinc	38.1	100	1.00E-06	1	152	3	36	3	4.4E-05	70	-
Industrial Worker (Off-site)											
Arsenic	6.31	100	1.00E-06	1	52	30	70	30	1.28E-06	70	5.50E-07
Chromium	10.50	100	1.00E-06	1	52	30	70	30	2.14E-06	-	-
Copper	5.60	100	1.00E-06	1	52	30	70	30	1.14E-06	-	-
Lead	355	100	1.00E-06	1	52	30	70	30	7E-05	70	3E-05
Zinc	22.0	100	1.00E-06	1	52	30	70	30	4.5E-06	70	-
Trespassing Child (Ages 10-12)											
Antimony	25	100	1.00E-06	1	4	3	36	3	8E-07	-	-
Arsenic	11.6	100	1.00E-06	1	4	3	36	3	3.5E-07	70	1.5E-08
Cadmium	3.32	100	1.00E-06	1	4	3	36	3	1.01E-07	-	-
Chromium	8.29	100	1.00E-06	1	4	3	36	3	2.52E-07	-	-
Copper	24.2	100	1.00E-06	1	4	3	36	3	7.4E-07	-	-
Lead	7500	100	1.00E-06	1	4	3	36	3	2E-04	70	1E-05
Zinc	57.2	100	1.00E-06	1	4	3	36	3	1.7E-06	-	-

TABLE 42
MSWJ, INC./NL INDUSTRIES, INC. SITE
INGESTION OF CHEMICALS IN SOIL

Chemical	CS (mg/kg)	IR (mg/day)	CF (kg/mg)	FI	EF (dy/yr)	ED (years)	BW (kg)	AT (yrs)	Intake	AT (years)	Intake
<hr/>											
Worker (On-Site)											
<hr/>											
Antimony	96	100	1.00E-06	1	52	30	70	30	2E-05	-	-
Arsenic	11.8	100	1.00E-06	1	52	30	70	30	2.4E-06	70	1.0E-06
Cadmium	3.50	100	1.00E-06	1	52	30	70	30	7.12E-07	-	-
Chromium	18.91	100	1.00E-06	1	52	30	70	30	3.85E-06	-	-
Copper	24.2	100	1.00E-06	1	52	30	70	30	4.9E-06	-	-
Lead	6636	100	1.00E-06	1	52	30	70	30	1E-03	70	6E-04
Zinc	56.5	100	1.00E-06	1	52	30	70	30	1.1E-05	-	-
<hr/>											

CS = chemical concentration in soil; IR = ingestion rate
 CF = conversion factor (10e-6 kg/mg); FI = fraction ingested from contaminated source
 EF = exposure frequency; ED = exposure duration
 BW = body weight; AT = averaging time
 - = not a carcinogen by this exposure pathway

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}} = \text{Intake (mg/kg-day)}$$

TABLE 43
NSNJ, INC./NL INDUSTRIES, INC. SITE
DERMAL CONTACT WITH CHEMICALS IN SOIL

Chemical	CS (mg/kg)	CF (kg/mg)	SA (cm ² /event)	AF (mg/cm ²)	ABS	EF (event/yr)	ED (years)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
Adult Resident (Off-site)												
Arsenic	9.63	1.00E-06	3120	0.51	0.01	52	30	70	30	3.12E-07	70	1.34E-07
Chromium	6.26	1.00E-06	3120	0.51	0.01	52	30	70	30	2.03E-07	-	-
Copper	8.79	1.00E-06	3120	0.51	0.01	52	30	70	30	2.85E-07	-	-
Lead	312	1.00E-06	3120	0.51	0.0006	52	30	70	30	6E-07	70	3E-07
Zinc	38.1	1.00E-06	3120	0.51	0.01	52	30	70	30	1.2E-06	-	-
Child Resident (Off-site; Ages 10-12)												
Arsenic	9.63	1.00E-06	2040	0.51	0.01	152	3	36	3	1.16E-06	70	4.97E-08
Chromium	6.26	1.00E-06	2040	0.51	0.01	152	3	36	3	7.53E-07	-	-
Copper	8.79	1.00E-06	2040	0.51	0.01	152	3	36	3	1.06E-06	-	-
Lead	312	1.00E-06	2040	0.51	0.0006	152	3	36	3	2E-06	70	1E-07
Zinc	38.1	1.00E-06	2040	0.51	0.01	152	3	36	3	4.6E-06	-	-
Industrial Worker (Off-site)												
Arsenic	6.31	1.00E-06	3120	0.51	0.01	52	30	70	30	2.04E-07	70	8.76E-08
Chromium	10.50	1.00E-06	3120	0.51	0.01	52	30	70	30	3.40E-07	-	-
Copper	5.60	1.00E-06	3120	0.51	0.01	52	30	70	30	1.81E-07	-	-
Lead	355	1.00E-06	3120	0.51	0.0006	52	30	70	30	7E-07	70	3E-07
Zinc	22.0	1.00E-06	3120	0.51	0.01	52	30	70	30	7.1E-07	-	-
Trespassing Child (Ages 10-12)												
Antimony	25	1.00E-06	2040	0.51	0.01	4	3	36	3	8E-08	-	-
Arsenic	11.6	1.00E-06	2040	0.51	0.01	4	3	36	3	3.7E-08	70	1.6E-09
Cadmium	3.32	1.00E-06	2040	0.51	0.01	4	3	36	3	1.05E-08	-	-
Chromium	8.29	1.00E-06	2040	0.51	0.01	4	3	36	3	2.63E-08	-	-
Copper	24.2	1.00E-06	2040	0.51	0.01	4	3	36	3	7.7E-08	-	-
Lead	7500	1.00E-06	2040	0.51	0.0006	4	3	36	3	1E-06	70	6E-08
Zinc	57.2	1.00E-06	2040	0.51	0.01	4	3	36	3	1.8E-07	-	-

TABLE 43
NSNJ, INC./NL INDUSTRIES, INC. SITE
DERMAL CONTACT WITH CHEMICALS IN SOIL

Chemical	CS (mg/kg)	CF (kg/mg)	SA (cm ² /event)	AF (mg/cm ²)	ABS	EF (event/yr)	ED (years)	BW (kg)	AT (yrs)	Intake	AT (yrs)	Intake
<hr/>												
Worker (On-Site)												
<hr/>												
Antimony	96	1.00E-06	3120	0.51	0.01	52	30	70	30	3.11E-06	-	-
Arsenic	11.8	1.00E-06	3120	0.51	0.01	52	30	70	30	3.82E-07	70	1.64E-07
Cadmium	3.50	1.00E-06	3120	0.51	0.01	52	30	70	30	1.13E-07	-	-
Chromium	18.91	1.00E-06	3120	0.51	0.01	52	30	70	30	6.12E-07	-	-
Copper	24.2	1.00E-06	3120	0.51	0.01	52	30	70	30	7.84E-07	-	-
Lead	6636	1.00E-06	3120	0.51	0.0006	52	30	70	30	1E-05	70	6E-06
Zinc	56.5	1.00E-06	3120	0.51	0.01	52	30	70	30	1.8E-06	-	-

CS = chemical concentration in soil; CF = conversion factor (10⁻⁶ kg/mg)

SA = skin surface area contacted; AF = soil to skin adherence factor

ABS = absorption factor; EF = exposure frequency

ED = exposure duration; BW = body weight

AT = averaging time

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}} = \text{Intake (mg/kg-day)}$$

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Intakes expressed in mg/kg/day

TABLE 45
NSNJ, INC./NL INDUSTRIES, INC. SITE
INTAKES BY OFF-SITE ADULT RESIDENTS

[illegible]

Intakes expressed in mg/kg/day

TABLE 46
NSNJ, INC./NL INDUSTRIES, INC. SITE
INTAKES BY OFF-SITE INDUSTRIAL WORKERS

[illegible]

Intakes expressed in mg/kg/day

Matrix >>>>>>>>>>>>>>>	SITE SOIL	SITE SOIL	SV	AIR
Intake Route >>>>>>>>>>>>	ING	DERM	DERM	INH
NONCARCINOGENIC EFFECTS:				
Antimony	2E-05	3.11E-06		6.90E-07
Arsenic	2.4E-06	3.82E-07		8.46E-08
Beryllium				
Cadmium	7.12E-07	1.13E-07		2.51E-08
Chromium	3.85E-06	6.12E-07		1.36E-07
Copper	4.9E-06	7.84E-07		1.74E-07
Lead	1E-03	1E-05	7.6E-06	4.75E-05
Nickel				
Selenium				
Sulfate			3.6E-04	
Thallium				
Tin				
Zinc	1.1E-05	1.8E-06		4.04E-07
1,1-Dichloroethane				
1,1-Dichloroethene				
Tetrachloroethene				
1,1,1-Trichloroethane				
Vinyl chloride				
CARCINOGENIC EFFECTS:				
Arsenic	1.0E-06	1.64E-07		3.63E-08
Beryllium				
Cadmium				1.08E-08
Chromium				5.82E-08
Lead	6E-04	6E-06	3.3E-06	2.04E-05
1,1-Dichloroethane				
1,1-Dichloroethene				
Tetrachloroethene				
Vinyl chloride				

Intakes expressed in mg/kg/day

TABLE 48
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUMMARY OF VALUES USED TO ESTIMATE SOIL EXPOSURES

Variable	Range	Midpoint	Value Used	Rationale
Chemical concentration				
Off-site resident	(see Table 34)	(see Table 34)	(see Table 34)	95% upperbound estimate of mean concentration (EPA 1989a) "
Trespassing child	(see Table 36)	(see Table 36)	(see Table 36)	
Off-site worker	(see Table 35)	(see Table 35)	(see Table 35)	
On-site worker	(see Table 36)	(see Table 36)	(see Table 36)	
		(arithmetic mean)		
Ingestion rate (mg/dy)				
Adult	0 - 170	17	100	EPA 1989a
Worker, child (10-12)		(arithmetic mean)	100	"
Skin surface area (m2) contacted				
Adult & Worker			0.312	arms & hands (EPA 1989b)
Child (ages 10-12)			0.204	arms & hands (EPA 1989b)
Skin absorption factor				
Lead	0 - 100%	50%	0.06%	Moore et al. 1980
Other metals	0 - 100%	50%	1%	Ryan 1987
% of soil contacted which is contaminated	0 - 100%	50%	100%	Best professional judgment
Exposure Frequency (days/year)				
Adult resident	0 - 365	183	52	EPA 1989b Part 1:2-54
Child resident	0 - 365	183	152	EPA 1989b Part 1:2-52
Worker	0 - 260	130	52	Best professional judgment
Trespassing Child	0 - 365	183	4	Site observation
Exposure Duration (yrs)				
Adult	1 - 70	35	30	EPA 1989a
Child (ages 10-12)	1 - 3	1.5	3	Best professional judgment
Worker	1 - 50	25	30	Best professional judgment

TABLE 49
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUMMARY OF VALUES USED TO ESTIMATE GROUND WATER EXPOSURES

Variable	Range	Midpoint	Value Used	Rationale
Chemical conc.	(see Table 23)	(see Table 32) (arithmetic mean)	(see Table 32)	95% upperbound estimate of mean conc. (EPA 1989a)
Ingestion rates (l/day)				
Adult resident	1.24 - 1.73	1.4	2	Reasonable worst case (EPA 1989a)
Child ages 10-12			2	Best professional judgment
Worker	0 - 1.73	0.9	1	Best professional judgment
Skin surface area (m ²) contacted				
Adult	1.16 - 2.28	1.94	1.94	total body (EPA 1989b)
Child (ages 10-12)		1.16	1.16	"
Dermal permeability constant			8E-4	Permeability constant for water
Exposure Frequency (days/year)				
Resident	0 - 365	183	365	Maximum value (EPA 1989a)
Worker	0 - 260	130	260	"
Dermal exposure time (minutes)		15	15	Average (EPA 1988)
Exposure Duration (years)				
Adult	1 - 70	35	30	Reasonable worst case (EPA 1989a)
Child (ages 10-12)	1 - 3	1.5	3	Best professional judgment
Worker	1 - 50	25	30	Best professional judgment

TABLE 50
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUMMARY OF VALUES USED TO ESTIMATE SURFACE WATER EXPOSURES

Variable	Range	Midpoint	Value Used	Rationale
Chemical conc.	(see Table 21)	(see Table 33) (arithmetic mean)	(see Table 33)	95% upperbound estimate of mean conc. (EPA 1989a)
Skin surface area contacted (m ²)				
Trespassing child			0.204	arms & hands (EPA 1989b)
Worker			0.312	arms & hands (EPA 1989b)
Dermal permeability constant			8E-4	Permeability constant for water
Exposure time (hrs/dy)	0 - 24	12	0.50	Best professional judgment
Exposure Frequency (days/year)				
Trespassing Child	0 - 365	183	4	Site observation
Worker	0 - 260	130	52	Best professional judgment
Exposure Duration (yr)				
Trespassing Child	0 - 3	1.5	3	Best professional judgment
Worker	0 - 50	25	30	Best professional judgment

TABLE 51
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUMMARY OF VALUES USED TO ESTIMATE AIR EXPOSURES

Variable	Range	Midpoint	Value Used	Rationale
Chemical concentration			(see Table 18)	Modeled - see Appendix
Inhalation rate (m ³ /hr)	0.3 - 4.8	1.4 (average)	3.0	Reasonable worst case (EPA 1989b)
Exposure time (hrs/event)	0 - 9	4.5	9	Maximum value
Exposure Frequency (dy/yr)	0 - 260	130	260	Maximum value
Exposure Duration (yrs)	1-50	25	30	Best professional judgment

TABLE 52
NSNJ, INC./NL INDUSTRIES, INC. SITE
UNCERTAINTIES IN THE EXPOSURE ASSESSMENT

ASSUMPTION	EFFECT ON EXPOSURE		
	Potential Magnitude for Over- Estimation of Exposure	Potential Magnitude for Under- Estimation of Exposure	Potential Magnitude for Over- or Under- Estimation of Exposure
ENVIRONMENTAL SAMPLING & ANALYSIS			
* Adequate characterization of environmental media			Low
* Systematic or random errors in the chemical analyses			Low
FATE AND TRANSPORT MODELING			
* Use of the 95% upper confidence limit on current mean GW concentrations to represent future concentrations in downgradient wells	High		
* Use of conservative model to determine on-site air concentrations	High		
* Use of the 95% upper confidence limit on current soil concentrations in air model	High		
EXPOSURE PARAMETER ESTIMATION			
* Use of standard assumptions in the risk calculations	Moderate		
* Use of the dermal permeability constant for water in calculating dermal exposures		Moderate	
* Use of GW ingestion exposures to represent GW inhalation exposures			Moderate
* The amount of media intake is assumed to be constant and representative of the exposed population	Moderate		
* Assumption of daily lifetime exposure for residents	Moderate		

GW = ground water

TABLE 53
MSNJ, INC./NL INDUSTRIES, INC. SITE
TOXICITY VALUES FOR POTENTIAL NONCARCINOGENIC
EFFECTS (CHRONIC ORAL EXPOSURES)

Chemical	Chronic RfD (mg/kg-day)	Confidence Level	Critical Effect	RfD Basis/ RfD Source	Uncertainty & Modifying Factors
Antimony	4E-04	low	longevity, blood chemistry	water/IRIS	UF=1000 (A,H,L), MF=1
Arsenic	1E-03		keratosis	HEAST	UF=1
Beryllium	5E-03	low	none observed	water/IRIS	UF=100 (A,H), MF=1
Cadmium	5E-04	high	renal damage	water/IRIS	UF=10 (H), MF=1
Chromium	5E-03	low	not defined	water/IRIS	UF=500 (A,H,S), MF=1
Copper	NA				
Lead	8E-04		none observed	water/EPA 1986	
Nickel	2E-02	medium	decreased organ wt	diet/IRIS	UF=100 (A,H), MF=3
Selenium	3E-03		hair/nail loss	diet/HEAST	UF=15
Thallium	7E-05		incr. SGOT/serum LDH	diet/HEAST	UF=3000
Zinc	2E-01		anemia	drug/HEAST	UF=10
Sulfate	NA				
1,1-Dichloroethane	1E-01		none	air/HEAST	UF=1000
1,1-Dichloroethene	9E-03	medium	liver lesions	water/IRIS	UF=1000 (A,H,L), MF=1
Tetrachloroethene	1E-02	medium	hepatotoxicity	gavage/IRIS	UF=1000 (A,H,S), MF=1
1,1,1-trichloroethane	9E-02	medium	hepatotoxicity	air/IRIS	UF=1000 (A,H,S), MF=1
vinyl chloride	NA				

* - confidence level from IRIS, either high, medium, or low
NA = not available

Uncertainty adjustments:

- H = variation in human sensitivity
- A = animal to human extrapolation
- S = extrapolation from subchronic to chronic NOAEL
- L = extrapolation from LOAEL to NOAEL

TABLE 54
 NSNJ, INC./NL INDUSTRIES, INC. SITE
 TOXICITY VALUES FOR POTENTIAL NONCARCINOGENIC
 EFFECTS (CHRONIC INHALATION EXPOSURES)

Chemical	Chronic RfD (mg/kg-day)	Confidence Level	Critical Effect	RfD Basis/ RfD Source	Uncertainty & Modifying Factors
1,1-Dichloroethane	1E-01		kidney damage	air/HEAST	UF=1000
1,1-Dichloroethene	4.86E-03			/ECAO	
Tetrachloroethene	NA				
1,1,1-trichloroethane	3E-01		hepatotoxicity	air/HEAST	UF=1000
vinyl chloride	NA				
Antimony	NA				
Arsenic	NA				
Cadmium	NA				
Chromium	NA				
Lead	NA				
Zinc	NA				

* - confidence level from IRIS, either high, medium, or low

NA = not available

Uncertainty adjustments:

- A = animal to human extrapolation
- H = variation in human sensitivity
- L = extrapolation from LOAEL to NOAEL
- S = extrapolation from subchronic to chronic NOAEL

TABLE 55
NSNJ, INC./NL INDUSTRIES, INC. SITE
TOXICITY VALUES FOR POTENTIAL NONCARCINOGENIC
EFFECTS (SUBCHRONIC ORAL EXPOSURES)

Chemical	Subchronic RfD (mg/kg-day)	Confidence Level	Critical Effect	RfD Basis/ RfD Source	Uncertainty Factors	Comments
Antimony	4E-04		longevity, blood chemistry	water/HEAST	UF=1000	
Arsenic	1E-03		keratosis	HEAST	UF=1	
Beryllium	5E-03		none observed	water/HEAST	UF=100	
Cadmium	5E-04		renal damage	water/IRIS	UF=10	a
Chromium	2E-02		not defined	water/HEAST	UF=100	
Copper	NA					
Lead	8E-04		none observed	water/EPA 1986		a
Nickel	2E-02		decreased organ wt	diet/HEAST	UF=300	
Selenium	4E-03		mortality	diet/HEAST	UF=100	
Thallium	7E-04		incr. SGOT/serum LDH	HEAST	UF=300	
Zinc	2E-01		anemia	drug/HEAST	UF=10	
Sulfate						
1,1-Dichloroethane	1E+00		none	air/HEAST	UF=100	
1,1-Dichloroethene	9E-03		liver lesions	water/HEAST	UF=1000	
Tetrachloroethene	1E-01		hepatotoxicity	gavage/HEAST	UF=100	
1,1,1-trichloroethane	9E-01		hepatotoxicity	air/HEAST	UF=100	
vinyl chloride	NA					

* - confidence level from IRIS, either high, medium, or low

a - the toxicity value for chronic exposures was used

TABLE 56
MSNJ, INC./NL INDUSTRIES, INC. SITE
TOXICITY VALUES FOR POTENTIAL NONCARCINOGENIC
EFFECTS (SUBCHRONIC INHALATION EXPOSURES)

Chemical	* Chronic		Critical Effect	RfD Basis/ RfD Source	Uncertainty Factors
	RfD (mg/kg-day)	Confidence Level			
1,1-Dichloroethane	1E+00		kidney damage	air/HEAST	UF=100
1,1-Dichloroethene	NA				
Tetrachloroethene	NA		hepatotoxicity	air/HEAST	UF=100
1,1,1-trichloroethane	3E+00				
vinyl chloride	NA				
Antimony	NA				
Arsenic	NA				
Cadmium	NA				
Chromium	NA				
Lead	NA				
Zinc	NA				

* - confidence level from IRIS, either high, medium, or low

TABLE 57
NSNJ, INC./NL INDUSTRIES, INC. SITE
TOXICITY VALUES FOR POTENTIAL CARCINOGENIC EFFECTS

Chemical	Slope Factor (SF) (mg/kg-day) ⁻¹	Weight-of Evidence Classification	* Type of Cancer	SF Basis/ SF Source	Comment	Based on Absorbed (ABS)/ Admin. (ADM) dose
ORAL						

Arsenic	1.7E+00	A	skin	water/IRIS	a	ADM
Beryllium	4.3E+00	B2		water/IRIS		ADM
Lead	NA	B2			b	
1,1-Dichloroethane	9.1E-02	C		gavage/HEAST		ADM
1,1-Dichloroethene	6E-01	C		water/IRIS		ADM
Tetrachloroethene	5E-02	B2		gavage/HEAST		ADM
vinyl chloride	2.3E+00	A	lung	diet/HEAST		ADM
INHALATION						

Arsenic	5.0E+01	A	resp. tract	air/HEAST		ABS
Cadmium	6.1E+00	B1		occup/IRIS		ADM
Chromium	4.1E+01	A	lung	occup/IRIS		ADM
Lead	NA				b	
1,1-Dichloroethene	1.2E+00	C		air/IRIS		ABS
Tetrachloroethene	3.3E-03	B2		air/HEAST		ADM
vinyl chloride	2.95E-01	A	liver	air/HEAST		ADM

Comments:

a = calculated from the proposed unit risk (see Appendix K)

b = not available per EPA personnel (EPA 1990d)

* - types of cancer for Class A carcinogens only

TABLE 58
MSNJ, INC./NL INDUSTRIES, INC. SITE
TOXICITY VALUE ADJUSTMENTS FOR DERMAL EXPOSURES

Chemical	Toxicity Value (RfD) (mg/kg-day)	Based on Absorb. (ABS)/ Admin. (ADM)	Study Species	Absorption Efficiency in Species	Adjusted Toxicity Value (mg/kg-day)
Chronic Exposures -----					
Antimony	4E-04	ADM	rat	0.05	2E-05
Arsenic	1E-03	ADM	human	0.95	1E-03
Beryllium	5E-03	ADM	rat	0.01	5E-05
Cadmium	5E-04	ABS	human		-
Chromium	5E-03	ADM	rat	0.03	2E-04
Lead	8E-04	ABS	human		-
Nickel	2E-02	ADM	rat	0.01	2E-04
Selenium	3E-03	ADM	human	0.90	3E-03
Thallium	7E-05	ADM	rat	0.05	4E-06
Zinc	2E-01	ADM	human	0.20	4E-02
1,1-Dichloroethane	1E-01	ADM	rat	0.50	5E-02
1,1-Dichloroethene	9E-03	ADM	rat	1.00	9E-03
Tetrachloroethene	1E-02	ADM	mouse	1.00	1E-02
1,1,1-trichloroethane	9E-02	ABS	guinea pig		-
Subchronic Exposures -----					
Antimony	4E-04	ADM	rat	0.05	2E-05
Arsenic	1E-03	ADM	human	0.95	1E-03
Beryllium	5E-03	ADM	rat	0.01	5E-05
Cadmium	5E-04	ABS	human		-
Chromium	2E-02	ADM	rat	0.03	6E-04
Lead	8E-04	ABS	human		-
Nickel	2E-02	ADM	rat	0.01	2E-04
Selenium	3E-03	ADM	human	0.90	3E-03
Thallium	7E-04	ADM	rat	0.05	4E-05
Zinc	2E-01	ADM	human	0.20	4E-02
1,1-Dichloroethane	1E+00	ADM	rat	0.50	5E-01
1,1-Dichloroethene	9E-03	ADM	rat	1.00	9E-03
Tetrachloroethene	1E-01	ADM	mouse	1.00	1E-01
1,1,1-trichloroethane	9E-01	ABS	guinea pig		-

TABLE 58 (cont.)
 NSNJ, INC./NL INDUSTRIES, INC. SITE
 TOXICITY VALUE ADJUSTMENTS FOR DERMAL EXPOSURES

Chemical	Toxicity Value (Slope Factor)	Based on Absorb. (ABS)/ Admin. (ADM)	Study Species	Absorption Efficiency in Species	Adjusted Toxicity Value (Slope Factor)
Arsenic	1.7E+00	ADM	human	0.95	1.8E+00
Beryllium	4.3E+00	ADM	rat	0.01	4.3E+02
1,1-Dichloroethane	9.1E-02	ADM	rat	0.50	1.8E-01
1,1-Dichloroethene	6E-01	ADM	rat	1.00	6E-01
Tetrachloroethene	5E-02	ADM	rat	1.00	5E-02
Vinyl chloride	2.3E+00	ADM	rat	1.00	2.3E+00

Notes: Only toxicity values based on administered doses were adjusted

Absorption efficiencies were obtained from ATSDR Toxicological Profiles

Slope factors expressed in (mg/kg-day)⁻¹

TABLE 59
NSNJ, INC./NL INDUSTRIES, INC. SITE
EXPOSURE ESTIMATE ADJUSTMENTS

Exposure/Receptor/Matrix	Exposure Estimate (mg/kg-day)	Human Absorption Efficiency for Pathway of Interest	Adjusted Exposure Estimate (mg/kg-day)
NONCARCINOGENIC EFFECTS			
ORAL - ADULT RESIDENT (OFF-SITE)			

SITE-WIDE GROUND WATER			
Cadmium	5.14E-03	0.05 #	2.57E-04
Lead	7.05E-02	0.50 *	3.53E-02
1,1,1-Trichloroethane	1.343E-01	0.90 *	1.21E-01
WELL 2R2			
Cadmium	2.86E-04	0.05 #	1.43E-05
Lead	1.143E-04	0.50 *	5.72E-05
WELL SD			
Cadmium	2.89E-02	0.05 #	1.45E-03
Lead	8.400E-03	0.50 *	4.20E-03
RESIDENTIAL SOIL			
Lead	6E-05	0.50 *	3.00E-05

ORAL - CHILD AGES 10-12 (OFF-SITE)			

SITE-WIDE GROUND WATER			
Cadmium	1.00E-02	0.05 #	5.00E-04
Lead	1.37E-01	0.50 *	6.85E-02
1,1,1-Trichloroethane	2.611E-01	0.90 *	2.35E-01
WELL 2R2			
Cadmium	5.56E-04	0.05 #	2.78E-05
Lead	2.222E-04	0.50 *	1.11E-04
WELL SD			
Cadmium	5.61E-02	0.05 #	2.81E-03
Lead	1.633E-02	0.50 *	8.17E-03
RESIDENTIAL SOIL			

TABLE 59
NSNJ, INC./NL INDUSTRIES, INC. SITE
EXPOSURE ESTIMATE ADJUSTMENTS

Exposure/Receptor/Matrix	Exposure Estimate (mg/kg-day)	Human Absorption Efficiency for Pathway of Interest	Adjusted Exposure Estimate (mg/kg-day)
Lead	4E-04	0.50 *	2.00E-04
SITE SOIL			
Cadmium	1.01E-07	0.05 #	5.05E-09
Lead	2E-04	0.50 *	1.00E-04

ORAL - WORKER (OFF-SITE)			

SITE-WIDE GROUND WATER			
Cadmium	1.83E-03	0.05 #	9.15E-05
Lead	2.51E-02	0.50 *	1.26E-02
1,1,1-Trichloroethane	4.783E-02	0.90 *	4.30E-02
WELL 2R2			
Cadmium	1.018E-04	0.05 #	5.09E-06
Lead	4.070E-05	0.50 *	2.04E-05
WELL SD			
Cadmium	1.028E-02	0.05 #	5.14E-04
Lead	2.992E-03	0.50 *	1.50E-03
INDUSTRIAL SOIL			
Lead	7E-05	0.50 *	3.50E-05

CARCINOGENIC EFFECTS			
INHALATION - ADULT RESIDENT (OFF-SITE)			

GROUND WATER			
1,1-Dichloroethene	2.082E-03	0.50 *	1.04E-03

INHALATION - CHILD AGES 10-12 (OFF-SITE)			

TABLE 59
MSNJ, INC./NL INDUSTRIES, INC. SITE
EXPOSURE ESTIMATE ADJUSTMENTS

Exposure/Receptor/Matrix	Exposure Estimate (mg/kg-day)	Human Absorption Efficiency for Pathway of Interest	Adjusted Exposure Estimate (mg/kg-day)
=====			
GROUND WATER			
1,1-Dichloroethene	4.048E-04	0.50 *	2.02E-04
INHALATION - WORKER (ON-SITE)			
=====			
SITE AIR			
Arsenic	3.630E-08	0.30 #	1.09E-08

Note: Exposure estimates were adjusted only for those chemicals for which toxicity values are based on absorbed doses (see Tables 57 & 58)

* = estimated based on information contained in ATSDR Toxicological Profiles.
= based on information contained in IRIS.

TABLE 60
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

Exposure Pathway	CDI (mg/kg-day)	SF (mg/kg-dy) ⁻¹	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical- Specific Risk	Total Pathway Risk	Total Exposure Risk
CURRENT EXPOSURES									

RESIDENTIAL SOIL INGESTION									
Arsenic	4.77E-07	1.7E+00	A	skin	IRIS	water	8E-07	8E-07	
RESIDENTIAL SOIL DERMAL ABSORPTION									
Arsenic	4.97E-08	1.8E+00 *	A	skin	IRIS	water	9E-08	9E-08	
SITE SOIL INGESTION									

Arsenic	1.5E-08	1.7E+00	A	skin	IRIS	water	3E-08	3E-08	
SITE SOIL DERMAL ABSORPTION									

Arsenic	1.6E-09	1.8E+00 *	A	skin	IRIS	water	3E-09	3E-09	
									9E-07
FUTURE EXPOSURES - TYPE 1									

GW INGESTION									
Arsenic	4.0E-05	1.7E+00	A	skin	IRIS	water	7E-05	5E-04	
Beryllium	1.667E-05	4.3E+00	B2		IRIS	water	7E-05		
1,1-Dichloroethane	1.762E-04	9.1E-02	C		HEAST	gavage	2E-05		
1,1-Dichloroethene	4.048E-04	6E-01	C		IRIS	water	2E-04		
Tetrachloroethene	4.286E-04	5E-02	B2		HEAST	gavage	2E-05		
Vinyl chloride	2.143E-05	2.3E+00	A	lung	HEAST	diet	5E-05		
GW DERMAL									
Arsenic	4.7E-08	1.8E+00 *	A	skin	IRIS	water	8E-08	9E-06	
Beryllium	1.93E-08	4.3E+02 *	B2		IRIS	water	8E-06		
1,1-Dichloroethane	2.04E-07	1.8E-01 *	C		HEAST	gavage	4E-08		
1,1-Dichloroethene	4.70E-07	6E-01 *	C		IRIS	water	3E-07		
Tetrachloroethene	4.97E-07	5E-02 *	B2		HEAST	gavage	2E-08		
Vinyl chloride	2.49E-08	2.3E+00 *	A	lung	HEAST	diet	6E-08		
GW INHALATION									
1,1-Dichloroethene	2.02E-04 *	1.2E+00	C		IRIS	air	2E-04		

TABLE 60
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

Exposure Pathway	CDI (mg/kg-day)	SF (mg/kg-dy) ⁻¹	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical- Specific Risk	Total Pathway Risk	Total Exposure Risk
Tetrachloroethene	4.286E-04	3.3E-03	B2		NEAST	air	1E-06		
Vinyl chloride	2.143E-05	2.95E-01	A	liver	NEAST	air	6E-06		
								3E-04	
RESIDENTIAL SOIL INGESTION									
Arsenic	4.77E-07	1.7E+00	A	skin	IRIS	water	8E-07		
								8E-07	
RESIDENTIAL SOIL DERMAL									
Arsenic	4.97E-08	1.8E+00 *	A	skin	IRIS	water	9E-08		
								9E-08	
									7E-04

FUTURE EXPOSURES - TYPE 2									

GW INGESTION (WELL 2R2)									
Arsenic	4.3E-02	1.7E+00	A	skin	IRIS	water	7E-02		
								7E-02	
GW DERMAL (WELL 2R2)									
Arsenic	5.03E-05	1.8E+00 *	A	skin	IRIS	water	9E-05		
								9E-05	
RESIDENTIAL SOIL INGESTION									
Arsenic	4.77E-07	1.7E+00	A	skin	IRIS	water	8E-07		
								8E-07	
RESIDENTIAL SOIL DERMAL									
Arsenic	4.97E-08	1.8E+00 *	A	skin	IRIS	water	9E-08		
								9E-08	
									7E-02

FUTURE EXPOSURES - TYPE 3									

GW INGESTION (WELL SD)									
Beryllium	3.714E-04	4.3E+00	B2		IRIS	water	2E-03		
								2E-03	
GW DERMAL (WELL SD)									
Beryllium	4.31E-07	4.3E+02 *	B2		IRIS	water	2E-04		
								2E-04	
RESIDENTIAL SOIL INGESTION									
Arsenic	4.77E-07	1.7E+00	A	skin	IRIS	water	8E-07		
								8E-07	

TABLE 60
 NSNJ, INC./NL INDUSTRIES, INC. SITE
 CANCER RISK ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

Exposure Pathway	CDI (mg/kg-day)	SF (mg/kg-dy) ⁻¹	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical- Specific Risk	Total Pathway Risk	Total Exposure Risk
RESIDENTIAL SOIL DERMAL									
Arsenic	4.97E-08	1.8E+00 *	A	skin	IRIS	water	9E-08	9E-08	2E-03

* = adjusted for absorption

Future - Type 1 = Ground water exposures are based on site-wide ground water quality

Future - Type 2 = Ground water exposures are based on Well 2R2 ground water quality

Future - Type 3 = Ground water exposures are based on Well SD ground water quality

Note: Lead was not included on the table since a slope factor was not obtained.

TABLE 61
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI (mg/kg/day)	SF (mg/kg-dy) ⁻¹	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical- Specific Risk	Total Pathway Risk	Total Exposure Risk
CURRENT EXPOSURES									

RESIDENTIAL SOIL INGESTION									
Arsenic	8.40E-07	1.7E+00	A	skin	IRIS	water	1E-06	1E-06	
RESIDENTIAL SOIL DERMAL									
Arsenic	1.34E-07	1.8E+00 *	A	skin	IRIS	water	2E-07	2E-07	2E-06
FUTURE EXPOSURES - TYPE 1									

GW INGESTION									
Arsenic	2.1E-04	1.7E+00	A	skin	IRIS	water	4E-04		
Beryllium	8.571E-05	4.3E+00	B2		IRIS	water	4E-04		
1,1-Dichloroethane	9.061E-04	9.1E-02	C		HEAST	gavage	8E-05		
1,1-Dichloroethene	2.082E-03	6E-01	C		IRIS	water	1E-03		
Tetrachloroethene	2.204E-03	5E-02	B2		HEAST	gavage	1E-04		
Vinyl chloride	1.102E-04	2.3E+00	A	lung	HEAST	diet	3E-04	2E-03	
GW DERMAL ABSORPTION									
Arsenic	4.0E-07	1.8E+00 *	A	skin	IRIS	water	7E-07		
Beryllium	1.66E-07	4.3E+02 *	B2		IRIS	water	7E-05		
1,1-Dichloroethane	1.76E-06	1.8E-01 *	B2		HEAST	gavage	3E-07		
1,1-Dichloroethene	4.04E-06	6E-01 *	C		IRIS	water	2E-06		
Tetrachloroethene	4.28E-06	5E-02 *	C		HEAST	gavage	2E-07		
Vinyl chloride	2.14E-07	2.3E+00 *	A	lung	HEAST	diet	5E-07	8E-05	
GW INHALATION									
1,1-Dichloroethene	1.04E-03 *	1.2E+00	C		IRIS	air	1E-03		
Tetrachloroethene	2.204E-03	3.3E-03	B2		HEAST	air	7E-06		
Vinyl chloride	1.102E-04	2.95E-01	A	liver	HEAST	air	3E-05	1E-03	
RESIDENTIAL SOIL INGESTION									
Arsenic	8.40E-07	1.7E+00	A	skin	IRIS	water	1E-06	1E-06	
RESIDENTIAL SOIL DERMAL									
Arsenic	1.34E-07	1.8E+00 *	A	skin	IRIS	water	2E-07	2E-07	4E-03

TABLE 61
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI (mg/kg/day)	SF (mg/kg-dy) ⁻¹	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical- Specific Risk	Total Pathway Risk	Total Exposure Risk
FUTURE EXPOSURES - TYPE 2									

GW INGESTION - WELL 2R2									
Arsenic	2.2E-01	1.7E+00	A	skin	IRIS	water	3E-01	3E-01	
GW DERMAL - WELL 2R2									
Arsenic	4.32E-04	1.8E+00 *	A	skin	IRIS	water	8E-04	8E-04	
RESIDENTIAL SOIL INGESTION									
Arsenic	8.40E-07	1.7E+00	A	skin	IRIS	water	1E-06	1E-06	
RESIDENTIAL SOIL DERMAL									
Arsenic	1.34E-07	1.8E+00 *	A	skin	IRIS	water	2E-07	2E-07	
									3E-01

FUTURE EXPOSURES - TYPE 3									

GW INGESTION - WELL SD									
Beryllium	1.910E-03	4.3E+00	B2		IRIS	water	8E-03	8E-03	
GW DERMAL - WELL SD									
Beryllium	3.71E-06	4.3E+02 *	B2		IRIS	water	2E-03	2E-03	
RESIDENTIAL SOIL INGESTION									
Arsenic	8.40E-07	1.7E+00	A	skin	IRIS	water	1E-06	1E-06	
RESIDENTIAL SOIL DERMAL									
Arsenic	1.34E-07	1.8E+00 *	A	skin	IRIS	water	2E-07	2E-07	
									1E-02

* = adjusted for absorption

Future - Type 1 = Ground water exposures are based on site-wide ground water quality

Future - Type 2 = Ground water exposures are based on Well 2R2 ground water quality

Future - Type 3 = Ground water exposures are based on Well SD ground water quality

Note: Lead was not included on the table since a slope factor was not obtained.

TABLE 62
MSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI (mg/kg-dy)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical- Specific Risk	Total Pathway Risk	Total Exposure Risk
CURRENT EXPOSURES									

INDUSTRIAL SOIL INGESTION									
Arsenic	5.50E-07	1.7E+00	A	skin	IRIS	water	9E-07	9E-07	

INDUSTRIAL SOIL DERMAL									
Arsenic	8.76E-08	1.8E+00 *	A	skin	IRIS	water	2E-07	2E-07	1E-06

FUTURE EXPOSURES - TYPE 1									

GW INGESTION									
Arsenic	7.4E-05	1.7E+00	A	skin	IRIS	water	1E-04		
Beryllium	3.053E-05	4.3E+00	B2		IRIS	water	1E-04		
1,1-Dichloroethane	3.227E-04	9.1E-02	C		HEAST	gavage	3E-05		
1,1-Dichloroethene	7.414E-04	6E-01	C		IRIS	water	4E-04		
Tetrachloroethene	7.850E-04	5E-02	B2		HEAST	gavage	4E-05		
Vinyl chloride	3.925E-05	2.3E+00	A	lung	HEAST	diet	9E-05		
								9E-04	

INDUSTRIAL SOIL INGESTION									
Arsenic	5.50E-07	1.7E+00	A	skin	IRIS	water	9E-07	9E-07	

INDUSTRIAL SOIL DERMAL									
Arsenic	8.76E-08	1.8E+00 *	A	skin	IRIS	water	2E-07	2E-07	9E-04

FUTURE EXPOSURES - TYPE 2									

GW INGESTION - WELL 2R2									
Arsenic	7.937E-02	1.7E+00	A	skin	IRIS	water	1E-01	1E-01	

INDUSTRIAL SOIL INGESTION									
Arsenic	5.50E-07	1.7E+00	A	skin	IRIS	water	9E-07	9E-07	

INDUSTRIAL SOIL DERMAL									
Arsenic	8.76E-08	1.8E+00 *	A	skin	IRIS	water	2E-07	2E-07	1E-01

TABLE 62
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI (mg/kg-dy)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical- Specific Risk	Total Pathway Risk	Total Exposure Risk
FUTURE EXPOSURES - TYPE 3 -----									
GW INGESTION - WELL SD									
Beryllium	6.803E-04	4.3E+00	B2		IRIS	water	3E-03	3E-03	
INDUSTRIAL SOIL INGESTION									
Arsenic	5.50E-07	1.7E+00	A	skin	IRIS	water	9E-07	9E-07	
INDUSTRIAL SOIL DERMAL									
Arsenic	8.76E-08	1.8E+00 *	A	skin	IRIS	water	2E-07	2E-07	3E-03

* = adjusted for absorption

Future - Type 1 = Ground water exposures are based on site-wide ground water quality

Future - Type 2 = Ground water exposures are based on Well 2R2 ground water quality

Future - Type 3 = Ground water exposures are based on Well SD ground water quality

Note: Lead was not included on the table since a slope factor was not obtained.

TABLE 63
MSNJ, INC./NL INDUSTRIES, INC. SITE
SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
CURRENT EXPOSURES									

RESIDENTIAL SOIL ING									
Arsenic	1.11E-05	1E-03	keratosis	HEAST	water	1	1.1E-02		
Chromium	7.24E-06	2E-02	not defined	HEAST	water	100	3.6E-04		
Lead	2E-04 *	8E-04	none observed	EPA 1986	water		2.5E-01		
Zinc	4.4E-05	2E-01	anemia	HEAST	drug	10	2.2E-04	2.6E-01	
RESIDENTIAL SOIL DERM									
Arsenic	1.16E-06	9E-04 *	keratosis	HEAST	water	1	1.3E-03		
Chromium	7.53E-07	6E-04 *	not defined	HEAST	water	100	1.3E-03		
Lead	2E-06	8E-04	none observed	EPA 1986	water		2.5E-03		
Zinc	4.6E-06	4E-02 *	anemia	HEAST	drug	10	1.2E-04		
								5.2E-03	
SITE SOIL ING									
Antimony	8E-07	4E-04	longevity	HEAST	water	1000	2.0E-03		
Arsenic	3.5E-07	1E-03	keratosis	HEAST	water	1	3.5E-04		
Cadmium	5.05E-09 *	5E-04	renal damage	IRIS	water	10	1.0E-05		
Chromium	2.52E-07	2E-02	not defined	HEAST	water	100	1.3E-05		
Lead	1E-04	8E-04	none observed	EPA 1986	water		1.3E-01		
Zinc	1.7E-06	2E-01	anemia	HEAST	drug	10	8.5E-06		
								1.3E-01	
SITE SOIL DERM									
Antimony	8E-08	2E-05 *	longevity	HEAST	water	1000	4.0E-03		
Arsenic	3.7E-08	9E-04 *	keratosis	HEAST	water	1	4.1E-05		
Cadmium	1.05E-08	5E-04	renal damage	IRIS	water	10	2.1E-05		
Chromium	2.63E-08	6E-04 *	not defined	HEAST	water	100	4.4E-05		
Lead	1E-06	8E-04	none observed	EPA 1986	water		1.2E-03		
Zinc	1.8E-07	4E-02 *	anemia	HEAST	drug	10	4.5E-06		
								5.4E-03	
SITE SW DERM									
Lead	7.5E-07	8E-04	none observed		water		9.4E-04		
								9.4E-04	
									0.40

TABLE 63
MSMJ, INC./NL INDUSTRIES, INC. SITE
SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

						RfD Uncert. Factor	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
	SDI	RfD	Critical Effect	RfD Source	RfD Basis	Adjust.			
FUTURE EXPOSURES - TYPE 1									

GROUND WATER INGESTION									
Antimony	4.444E-03	4E-04	longevity	HEAST	water	1000	1E+01		
Arsenic	9.4E-04	1E-03	keratosis	HEAST	water	1	9E-01		
Beryllium	3.889E-04	5E-03	none observed	HEAST	water	100	8E-02		
Cadmium	5.00E-04 *	5E-04	renal damage	IRIS	water	10	1E+00		
Chromium	6.278E-03	2E-02	not defined	HEAST	water	100	3E-01		
Lead	6.85E-02 *	8E-04	none observed	EPA 1986	water		9E+01		
Nickel	7.78E-03	2E-02	decr. organ wt.	HEAST	diet	300	4E-01		
Selenium	1.111E-03	4E-03	mortality	HEAST	diet	100	3E-01		
Thallium	5.556E-05	7E-04	blood effects	HEAST	?	300	8E-02		
Zinc	3.35E-02	2E-01	anemia	HEAST	drug	10	2E-01		
1,1-Dichloroethane	4.111E-03	1E+00	none	HEAST	air	100	4E-03		
1,1-Dichloroethene	9.444E-03	9E-03	liver lesions	HEAST	water	1000	1E+00		
Tetrachloroethene	1.000E-02	1E-01	hepatotoxicity	HEAST	gavage	100	1E-01		
1,1,1-Trichloroethane	2.35E-01 *	9E-01	hepatotoxicity	HEAST	air	100	3E-01		
									101.40
GROUND WATER DERM									
Antimony	5.16E-06	2E-05 *	longevity	HEAST	water	1000	3E-01		
Arsenic	1.10E-06	9E-04 *	keratosis	HEAST	water	1	1E-03		
Beryllium	4.51E-07	5E-05 *	none observed	HEAST	water	100	9E-03		
Cadmium	1.16E-05	5E-04	renal damage	IRIS	water	10	2E-02		
Chromium	7.28E-06	6E-04 *	not defined	HEAST	water	100	1E-02		
Lead	1.59E-04	8E-04	none observed	EPA 1986	water		2E-01		
Nickel	9.02E-06	2E-04 *	decr. organ wt.	HEAST	diet	300	5E-02		
Selenium	1.29E-06	3E-03 *	mortality	HEAST	diet	100	4E-04		
Thallium	6.44E-08	4E-05 *	blood effects	HEAST	?	300	2E-03		
Zinc	3.89E-05	4E-02 *	anemia	HEAST	drug	10	1E-03		
1,1-Dichloroethane	4.77E-06	5E-01 *	none	HEAST	air	100	1E-05		
1,1-Dichloroethene	1.10E-05	9E-03 *	liver lesions	HEAST	water	1000	1E-03		
Tetrachloroethene	1.16E-05	1E-01 *	hepatotoxicity	HEAST	gavage	100	1E-04		
1,1,1-Trichloroethane	3.03E-04	9E-01	hepatotoxicity	HEAST	air	100	3E-04		
									0.55
GROUND WATER INHALATION									
1,1-Dichloroethane	4.11E-03	1E+00	kidney damage	HEAST	air	100	4E-03		
1,1,1-Trichloroethane	2.611E-01	3E+00	hepatotoxicity	HEAST	air	100	9E-02		
									0.09

TABLE 63
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
RESIDENTIAL SOIL ING									
Arsenic	1.11E-05	1E-03	keratosis	HEAST	water	1	1.1E-02		
Chromium	7.24E-06	2E-02	not defined	HEAST	water	100	3.6E-04		
Lead	2.00E-04 *	8E-04	none observed	EPA 1986	water		2.5E-01		
Zinc	4.4E-05	2E-01	anemia	HEAST	drug	10	2.2E-04		
									2.6E-01
RESIDENTIAL SOIL DERM									
Arsenic	1.16E-06	9E-04 *	keratosis	HEAST	water	1	1.3E-03		
Chromium	7.53E-07	6E-04 *	not defined	HEAST	water	100	1.3E-03		
Lead	2E-06	8E-04	none observed	EPA 1986	water		2.5E-03		
Zinc	4.6E-06	4E-02 *	anemia	HEAST	drug	10	1.2E-04		
									5.2E-03
SITE SOIL ING									
Antimony	8E-07	4E-04	longevity	HEAST	water	1000	2.0E-03		
Arsenic	3.5E-07	1E-03	keratosis	HEAST	water	1	3.5E-04		
Cadmium	5.05E-09 *	5E-04	renal damage	IRIS	water	10	1.0E-05		
Chromium	2.52E-07	2E-02	not defined	HEAST	water	100	1.3E-05		
Lead	1.00E-04 *	8E-04	none observed	EPA 1986	water		1.3E-01		
Zinc	1.7E-06	2E-01	anemia	HEAST	drug	10	8.5E-06		
									1.3E-01
SITE SOIL DERM									
Antimony	8E-08	2E-05 *	longevity	HEAST	water	1000	4.0E-03		
Arsenic	3.7E-08	9E-04 *	keratosis	HEAST	water	1	4.1E-05		
Cadmium	1.05E-08	5E-04	renal damage	IRIS	water	10	2.1E-05		
Chromium	2.63E-08	6E-04 *	not defined	HEAST	water	100	4.4E-05		
Lead	1E-06	8E-04	none observed	EPA 1986	water		1.2E-03		
Zinc	1.8E-07	4E-02 *	anemia	HEAST	drug	10	4.5E-06		
									5.4E-03
SITE SW DERM									
Lead	7.5E-07	8E-04	none observed	EPA 1986	water		9.4E-04		
									9.4E-04
									102.44

TABLE 63
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
FUTURE EXPOSURES - TYPE 2									

WELL 2R2 - INGESTION									
Arsenic	1.0E+00	1E-03	keratosis	HEAST	water	1	1E+03		
Cadmium	2.78E-05 *	5E-04	renal damage	IRIS	water	10	6E-02		
Chromium	4.44E-04	2E-02	not defined	HEAST	water	100	2E-02		
Lead	1.11E-04 *	8E-04	none observed	EPA 1986	water		1E-01		
								1000.22	
WELL 2R2 - DERMAL									
Arsenic	1.17E-03	9E-04 *	keratosis	HEAST	water	1	1E+00		
Cadmium	6.44E-07	5E-04	renal damage	IRIS	water	10	1E-03		
Chromium	5.16E-07	6E-04 *	not defined	HEAST	water	100	9E-04		
Lead	2.58E-07	8E-04	none observed	EPA 1986	water		3E-04		
								1.30	
RESIDENTIAL SOIL ING									
Arsenic	1.11E-05	1E-03	keratosis	HEAST	water	1	1.1E-02		
Chromium	7.24E-06	2E-02	not defined	HEAST	water	100	3.6E-04		
Lead	2.00E-04 *	8E-04	none observed	EPA 1986	water		2.5E-01		
Zinc	4.4E-05	2E-01	anemia	HEAST	drug	10	2.2E-04		
								2.6E-01	
RESIDENTIAL SOIL DERM									
Arsenic	1.16E-06	9E-04 *	keratosis	HEAST	water	1	1.3E-03		
Chromium	7.53E-07	6E-04 *	not defined	HEAST	water	100	1.3E-03		
Lead	2E-06	8E-04	none observed	EPA 1986	water		2.5E-03		
Zinc	4.6E-06	4E-02 *	anemia	HEAST	drug	10	1.2E-04		
								5.2E-03	
SITE SW DERM									
Lead	7.5E-07	8E-04	none observed	EPA 1986	water		9.4E-04		
								9.4E-04	
									1001.79
FUTURE EXPOSURES - TYPE 3									

WELL SD - INGESTION									
Beryllium	8.667E-03	5E-03	none observed	HEAST	water	100	2E+00		
Cadmium	2.81E-03 *	5E-04	renal damage	IRIS	water	10	6E+00		
Chromium	2.411E-01	2E-02	not defined	HEAST	water	100	1E+01		
Lead	8.17E-03 *	8E-04	none observed	EPA 1986	water		1E+01		

TABLE 63
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
Nickel	1.07E-01	2E-02	decr. organ wt.	HEAST	diet	300	5E+00		
Thallium	1.667E-04	7E-04	blood effects	HEAST	?	300	2E-01		
Zinc	4.80E-01	2E-01	anemia	HEAST	drug	10	2E+00		
									37.61
WELL SD - DERMAL									
Beryllium	1.01E-05	5E-05 *	none observed	HEAST	water	100	2E-01		
Cadmium	6.51E-05	5E-04	renal damage	IRIS	water	10	1E-01		
Chromium	2.80E-04	6E-04 *	not defined	HEAST	water	100	5E-01		
Lead	1.89E-05	8E-04	none observed	EPA 1986	water		2E-02		
Nickel	1.24E-04	2E-04 *	decr. organ wt.	HEAST	diet	300	6E-01		
Thallium	1.93E-07	4E-05 *	blood effects	HEAST	?	300	5E-03		
Zinc	5.57E-04	4E-02 *	anemia	HEAST	drug	10	1E-02		
									1.46
RESIDENTIAL SOIL ING									
Arsenic	1.11E-05	1E-03	keratosis	HEAST	water	1	1.1E-02		
Chromium	7.24E-06	2E-02	not defined	HEAST	water	100	3.6E-04		
Lead	2.00E-04 *	8E-04	none observed	EPA 1986	water		2.5E-01		
Zinc	4.4E-05	2E-01	anemia	HEAST	drug	10	2.2E-04		
									2.6E-01
RESIDENTIAL SOIL DERM									
Arsenic	1.16E-06	9E-04 *	keratosis	HEAST	water	1	1.3E-03		
Chromium	7.53E-07	6E-04 *	not defined	HEAST	water	100	1.3E-03		
Lead	2E-06	8E-04	none observed	EPA 1986	water		2.5E-03		
Zinc	4.6E-06	4E-02 *	anemia	HEAST	drug	10	1.2E-04		
									5.2E-03
SITE SW DERM									
Lead	7.5E-07	8E-04	none observed	EPA 1986	water		9.4E-04		
									9.4E-04
									39.34

* = adjusted for absorption
SDIs and RfDs expressed in mg/kg-day

TABLE 64
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
CURRENT EXPOSURES									

RESIDENTIAL SOIL ING									
Arsenic	1.96E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Chromium	1.27E-06	5E-03	not defined	IRIS	water	500	3E-04		
Lead	3.00E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	7.8E-06	2E-01	anemia	HEAST	drug	10	4E-05		
								4E-02	
RESIDENTIAL SOIL DERM									
Arsenic	3.12E-07	9E-04 *	keratosis	HEAST	water	1	3E-04		
Chromium	2.03E-07	1E-04 *	not defined	IRIS	water	500	2E-03		
Lead	6E-07	8E-04	none observed	EPA 1986			7E-04		
Zinc	1.2E-06	4E-02 *	anemia	HEAST	drug	10	3E-05		
								3E-03	
									0.04
FUTURE EXPOSURES - TYPE 1									

GROUND WATER INGESTION									
Antimony	2.286E-03	4E-04	longevity	IRIS	water	1000	6E+00		
Arsenic	4.9E-04	1E-03	keratosis	HEAST	water	1	5E-01		
Beryllium	2.000E-04	5E-03	none observed	IRIS	water	100	4E-02		
Cadmium	2.57E-04 *	5E-04	renal damage	IRIS	water	10	5E-01		
Chromium	3.229E-03	5E-03	not defined	IRIS	water	500	6E-01		
Lead	3.52E-02 *	8E-04	none observed	EPA 1986	water		4E+01		
Nickel	4.00E-03	2E-02	decr. organ wt.	IRIS	diet	100	2E-01		
Selenium	5.714E-04	3E-03	hair/nail loss	HEAST	diet	15	2E-01		
Thallium	2.857E-05	7E-05	blood effects	HEAST	diet	3000	4E-01		
Zinc	1.72E-02	2E-01	anemia	HEAST	drug	10	9E-02		
1,1-Dichloroethane	2.114E-03	1E-01	none	HEAST	air	1000	2E-02		
1,1-Dichloroethene	4.857E-03	9E-03	liver lesions	IRIS	water	1000	5E-01		
Tetrachloroethene	5.143E-03	1E-02	hepatotoxicity	IRIS	gavage	1000	5E-01		
1,1,1-Trichloroethane	1.21E-01 *	9E-02	hepatotoxicity	IRIS	air	1000	1E+00		
								55	
GROUND WATER DERMAL									
Antimony	4.43E-06	2E-05 *	longevity	IRIS	water	1000	2E-01		

TABLE 64
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
Arsenic	9.42E-07	9E-04 *	keratosis	HEAST	water	1	1E-03		
Beryllium	3.88E-07	5E-05 *	none observed	IRIS	water	100	8E-03		
Cadmium	9.98E-06	5E-04	renal damage	IRIS	water	10	2E-02		
Chromium	6.26E-06	1E-04 *	not defined	IRIS	water	500	6E-02		
Lead	1.37E-04	8E-04	none observed	EPA 1986	water		2E-01		
Nickel	7.76E-06	2E-04 *	decr. organ wt.	IRIS	diet	100	4E-02		
Selenium	1.11E-06	3E-03 *	hair/nail loss	HEAST	diet	15	4E-04		
Thallium	5.54E-08	3E-06 *	blood effects	HEAST	diet	3000	2E-02		
Zinc	3.34E-05	4E-02 *	anemia	HEAST	drug	10	8E-04		
1,1-Dichloroethane	4.10E-06	5E-02 *	none	HEAST	air	1000	8E-05		
1,1-Dichloroethene	9.42E-06	9E-03 *	liver lesions	IRIS	water	1000	1E-03		
Tetrachloroethene	9.98E-06	1E-02 *	hepatotoxicity	IRIS	gavage	1000	1E-03		
1,1,1-Trichloroethane	2.61E-04	9E-02	hepatotoxicity	IRIS	air	1000	3E-03		
								5E-01	
GROUND WATER INHALATION									
1,1-Dichloroethane	2.114E-03	1E-01	kidney damage	HEAST	air	1000	2E-02		
1,1-Dichloroethene	4.857E-03	4.86E-03		ECAO			1E+00		
1,1,1-Trichloroethane	1.343E-01	3E-01	hepatotoxicity	HEAST	air	1000	4E-01		
								1E+00	
RESIDENTIAL SOIL ING									
Arsenic	1.96E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Chromium	1.27E-06	5E-03	not defined	IRIS	water	500	3E-04		
Lead	3E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	7.8E-06	2E-01	anemia	HEAST	drug	10	4E-05		
								4E-02	
RESIDENTIAL SOIL DERM									
Arsenic	3.12E-07	9E-04 *	keratosis	HEAST	water	1	3E-04		
Chromium	2.03E-07	1E-04 *	not defined	IRIS	water	500	2E-03		
Lead	6E-07	8E-04	none observed	EPA 1986	water		7E-04		
Zinc	1.2E-06	4E-02 *	anemia	HEAST	drug	10	3E-05		
								3E-03	

57

FUTURE EXPOSURES - TYPE 2

WELL 2R2 - INGESTION

Arsenic	5.2E-01	1E-03	keratosis	HEAST	water	1	5E+02
Cadmium	1.43E-05 *	5E-04	renal damage	IRIS	water	10	3E-02

TABLE 64
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
Chromium	2.286E-04	5E-03	not defined	IRIS	water	500	5E-02		
Lead	5.72E-05 *	8E-04	none observed	EPA 1986	water		7E-02		
								520.1	
WELL 2R2 - DERMAL									
Arsenic	1.01E-03	9E-04 *	keratosis	HEAST	water	1	1E+00		
Cadmium	5.54E-07	5E-04	renal damage	IRIS	water	10	1E-03		
Chromium	4.43E-07	1E-04 *	not defined	IRIS	water	500	4E-03		
Lead	2.22E-07	8E-04	none observed	EPA 1986	water		3E-04		
								1.1	
RESIDENTIAL SOIL ING									
Arsenic	1.96E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Chromium	1.27E-06	5E-03	not defined	IRIS	water	500	3E-04		
Lead	3E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	7.8E-06	2E-01	anemia	HEAST	drug	10	4E-05		
								0.04	
RESIDENTIAL SOIL DERM									
Arsenic	3.12E-07	9E-04 *	keratosis	HEAST	water	1	3E-04		
Chromium	2.03E-07	1E-04 *	not defined	IRIS	water	500	2E-03		
Lead	6E-07	8E-04	none observed	EPA 1986	water		7E-04		
Zinc	1.2E-06	4E-02 *	anemia	HEAST	drug	10	3E-05		
								3E-03	
									521.3
FUTURE EXPOSURES - TYPE 3									

WELL SD - INGESTION									
Beryllium	4.457E-03	5E-03	none observed	IRIS	water	100	9E-01		
Cadmium	1.45E-03 *	5E-04	renal damage	IRIS	water	10	3E+00		
Chromium	1.240E-01	5E-03	not defined	IRIS	water	500	2E+01		
Lead	4.20E-03 *	8E-04	none observed	EPA 1986	water		5E+00		
Nickel	5.51E-02	2E-02	decr. organ wt.	IRIS	diet	100	3E+00		
Thallium	8.571E-05	7E-05	blood effects	HEAST	diet	3000	1E+00		
Zinc	2.47E-01	2E-01	anemia	HEAST	drug	10	1E+00		
								39.1	
WELL SD - DERMAL									
Beryllium	8.65E-06	5E-05 *	none observed	IRIS	water	100	2E-01		
Cadmium	5.60E-05	5E-04	renal damage	IRIS	water	10	1E-01		
Chromium	2.41E-04	1E-04 *	not defined	IRIS	water	500	2E+00		

TABLE 64
 MSNJ, INC./NL INDUSTRIES, INC. SITE
 CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
Lead	1.63E-05	8E-04	none observed	EPA 1986	water		2E-02		
Nickel	1.07E-04	2E-04 *	decr. organ wt.	IRIS	diet	100	5E-01		
Thallium	1.66E-07	3E-06 *	blood effects	HEAST	diet	3000	6E-02		
Zinc	4.79E-04	4E-02 *	anemia	HEAST	drug	10	1E-02		
								3.3	
RESIDENTIAL SOIL ING									
Arsenic	1.96E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Chromium	1.27E-06	5E-03	not defined	IRIS	water	500	3E-04		
Lead	3E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	7.8E-06	2E-01	anemia	HEAST	drug	10	4E-05		
								4E-02	
RESIDENTIAL SOIL DERM									
Arsenic	3.12E-07	9E-04 *	keratosis	HEAST	water	1	3E-04		
Chromium	2.03E-07	1E-04 *	not defined	IRIS	water	500	2E-03		
Lead	6E-07	8E-04	none observed	EPA 1986	water		7E-04		
Zinc	1.2E-06	4E-02 *	anemia	HEAST	drug	10	3E-05		
								3E-03	
									42.4

Note: CDIs and RfDs expressed in mg/kg-day

* = adjusted for absorption

ING = ingestion, DERM = dermal absorption

TABLE 65
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
CURRENT EXPOSURES									

INDUSTRIAL SOIL ING.									
Arsenic	1.28E-06	1E-03	keratosis	NEAST	water	1	1.3E-03		
Chromium	2.14E-06	5E-03	not defined	IRIS	water	500	4.3E-04		
Lead	3.5E-05 *	8E-04	none observed	EPA 1986	water		4.4E-02		
Zinc	4.5E-06	2E-01	anemia	NEAST	drug	10	2.3E-05		
								4.5E-02	
INDUSTRIAL SOIL DERMAL									
Arsenic	2.04E-07	9E-04 *	keratosis	NEAST	water	1	2.3E-04		
Chromium	3.40E-07	1E-04 *	not defined	IRIS	water	500	3.4E-03		
Lead	7E-07	8E-04	none observed	EPA 1986	water		8.8E-04		
Zinc	7.1E-07	4E-02 *	anemia	NEAST	drug	10	1.8E-05		
								4.5E-03	
									0.05

FUTURE EXPOSURES - TYPE 1

GROUND WATER INGESTION

Antimony	8.141E-04	4E-04	longevity	IRIS	water	1000	2E+00		
Arsenic	1.7E-04	1E-03	keratosis	NEAST	water	1	2E-01		
Beryllium	7.123E-05	5E-03	none observed	IRIS	water	100	1E-02		
Cadmium	9.15E-05 *	5E-04	renal damage	IRIS	water	10	2E-01		
Chromium	1.150E-03	5E-03	not defined	IRIS	water	500	2E-01		
Lead	1.26E-02 *	8E-04	none observed	EPA 1986	water		2E+01		
Nickel	1.42E-03	2E-02	decr. organ wt.	IRIS	diet	100	7E-02		
Selenium	2.035E-04	3E-03	hair/nail loss	NEAST	diet	15	7E-02		
Thallium	1.018E-05	7E-05	blood effects	NEAST	diet	3000	1E-01		
Zinc	6.14E-03	2E-01	anemia	NEAST	drug	10	3E-02		
1,1-Dichloroethane	7.530E-04	1E-01	none	NEAST	air	1000	8E-03		
1,1-Dichloroethene	1.730E-03	9E-03	liver lesions	IRIS	water	1000	2E-01		
Tetrachloroethene	1.832E-03	1E-02	hepatotoxicity	IRIS	gavage	1000	2E-01		
1,1,1-Trichloroethane	4.30E-02 *	9E-02	hepatotoxicity	IRIS	air	1000	5E-01		

19.56

TABLE 65
MSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
INDUSTRIAL SOIL INGESTION									
Arsenic	1.28E-06	1E-03	keratosis	HEAST	water	1	1E-03		
Chromium	2.14E-06	5E-03	not defined	IRIS	water	500	4E-04		
Lead	3.50E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	4.5E-06	2E-01	anemia	HEAST	drug	10	2E-05		
								5E-02	
INDUSTRIAL SOIL DERMAL									
Arsenic	2.04E-07	9E-04 *	keratosis	HEAST	water	1	2E-04		
Chromium	3.40E-07	1E-04 *	not defined	IRIS	water	500	3E-03		
Lead	7E-07	8E-04	none observed	EPA 1986	water		9E-04		
Zinc	7.1E-07	4E-02 *	anemia	HEAST	drug	10	2E-05		
								5E-03	
									19.61
FUTURE EXPOSURES - TYPE 2									

WELL 2R2 INGESTION									
Arsenic	1.852E-01	1E-03	keratosis	HEAST	water	1	2E+02		
Cadmium	5.09E-06 *	5E-04	renal damage	IRIS	water	10	1E-02		
Chromium	8.141E-05	5E-03	not defined	IRIS	water	500	2E-02		
Lead	2.03E-05 *	8E-04	none observed	EPA 1986	water		3E-02		
								185	
INDUSTRIAL SOIL INGESTION									
Arsenic	1.28E-06	1E-03	keratosis	HEAST	water	1	1E-03		
Chromium	2.14E-06	5E-03	not defined	IRIS	water	500	4E-04		
Lead	3.50E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	4.5E-06	2E-01	anemia	HEAST	drug	10	2E-05		
								5E-02	
INDUSTRIAL SOIL DERMAL									
Arsenic	2.04E-07	9E-04 *	keratosis	HEAST	water	1	2E-04		
Chromium	3.40E-07	1E-04 *	not defined	IRIS	water	500	3E-03		
Lead	7E-07	8E-04	none observed	EPA 1986	water		9E-04		
Zinc	7.1E-07	4E-02 *	anemia	HEAST	drug	10	2E-05		
								5E-03	
									185

TABLE 65
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
FUTURE EXPOSURES - TYPE 3									

WELL SD INGESTION									
Beryllium	1.587E-03	5E-03	none observed	IRIS	water	100	3E-01		
Cadmium	5.14E-04 *	5E-04	renal damage	IRIS	water	10	1E+00		
Chromium	4.416E-02	5E-03	not defined	IRIS	water	500	9E+00		
Lead	1.50E-03 *	8E-04	none observed EPA 1986		water		2E+00		
Nickel	1.964E-02	2E-02	decr. organ wt.	IRIS	diet	100	1E+00		
Thallium	3.053E-05	7E-05	blood effects	HEAST	diet	3000	4E-01		
Zinc	8.792E-02	2E-01	anemia	HEAST	drug	10	4E-01		
									14
INDUSTRIAL SOIL INGESTION									
Arsenic	1.28E-06	1E-03	keratosis	HEAST	water	1	1E-03		
Chromium	2.14E-06	5E-03	not defined	IRIS	water	500	4E-04		
Lead	3.50E-05 *	8E-04	none observed EPA 1986		water		4E-02		
Zinc	4.5E-06	2E-01	anemia	HEAST	drug	10	2E-05		
									5E-02
INDUSTRIAL SOIL DERMAL									
Arsenic	2.04E-07	9E-04 *	keratosis	HEAST	water	1	2E-04		
Chromium	3.40E-07	1E-04 *	not defined	IRIS	water	500	3E-03		
Lead	7E-07	8E-04	none observed EPA 1986		water		9E-04		
Zinc	7.1E-07	4E-02 *	anemia	HEAST	drug	10	2E-05		
									5E-03
									14

* = adjusted for absorption

CDIs and RfDs expressed in mg/kg-day

TABLE 66
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN ON-SITE WORKER

Exposure Pathway	CDI (mg/kg/day)	SF (mg/kg-dy) ⁻¹	Mt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical- Specific Risk	Total Pathway Risk	Total Exposure Risk
FUTURE EXPOSURES									

SITE SOIL INGESTION									
Arsenic	1.0E-06	1.7E+00	A	skin	IRIS	water	2E-06		
								2E-06	
SITE SOIL DERMAL									
Arsenic	1.64E-07	1.8E+00 *	A	skin	IRIS	water	3E-07		
								3E-07	
SITE AIR INHALATION									
Arsenic	1.09E-08 *	5.0E+01	A	respir.	HEAST	air	5E-07		
Cadmium	1.08E-08	6.1E+00	B1		IRIS	occup	7E-08		
Chromium	5.82E-08	4.1E+01	A	lung	IRIS	occup	2E-06		
								3E-06	
									5E-06

* = adjusted for absorption

Note: Lead was not included on the table since a slope factor was not obtained.

TABLE 67
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN ON-SITE WORKER

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
FUTURE EXPOSURES									

SITE SOIL INGESTION									
Antimony	2E-05	4E-04	longevity	IRIS	water	1000	5E-02		
Arsenic	2.4E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Cadmium	3.56E-08 *	5E-04	renal damage	IRIS	water	10	7E-05		
Chromium	3.85E-06	5E-03	not defined	IRIS	water	500	8E-04		
Lead	5E-04 *	8E-04	none observed	EPA 1986	water		6E-01		
Zinc	1.1E-05	2E-01	anemia	HEAST	drug	10	6E-05		
								0.68	
SITE SOIL DERMAL									
Antimony	3.11E-06	2E-05 *	longevity	IRIS	water	1000	2E-01		
Arsenic	3.82E-07	9E-04 *	keratosis	HEAST	water	1	4E-04		
Cadmium	1.13E-07	5E-04	renal damage	IRIS	water	10	2E-04		
Chromium	6.12E-07	1E-04 *	not defined	IRIS	water	500	6E-03		
Lead	1E-05	8E-04	none observed	EPA 1986	water		1E-02		
Zinc	1.8E-06	4E-02 *	anemia	HEAST	drug	10	5E-05		
								0.17	
SURFACE WATER DERMAL									
Lead	7.6E-06	8E-04	none observed	EPA 1986	water		1E-02		
								0.01	
									0.9

Note: CDIs and RfDs expressed in mg/kg-day

* = adjusted for absorption

Figures

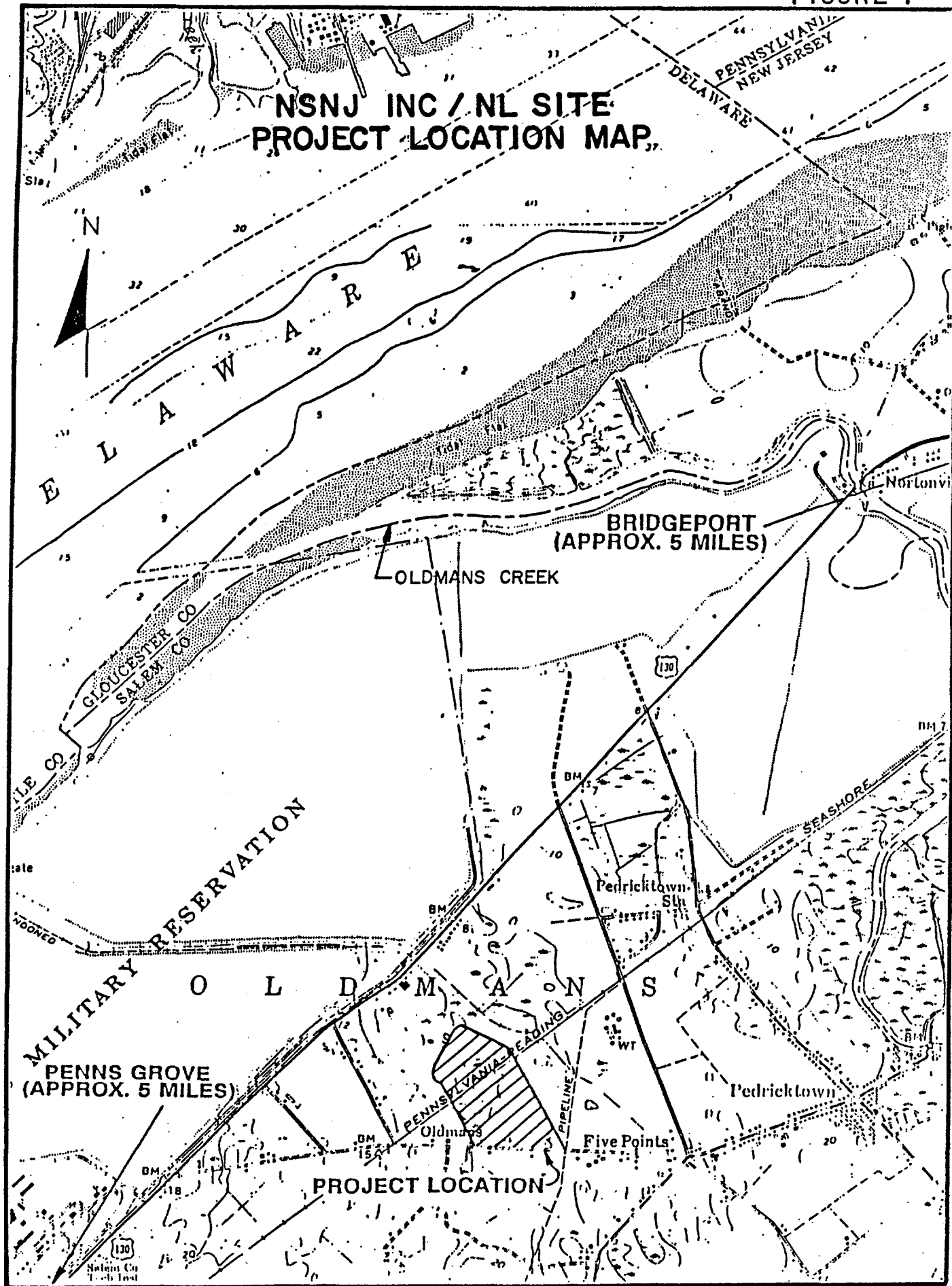


OBRIEN & GERE

FIGURES

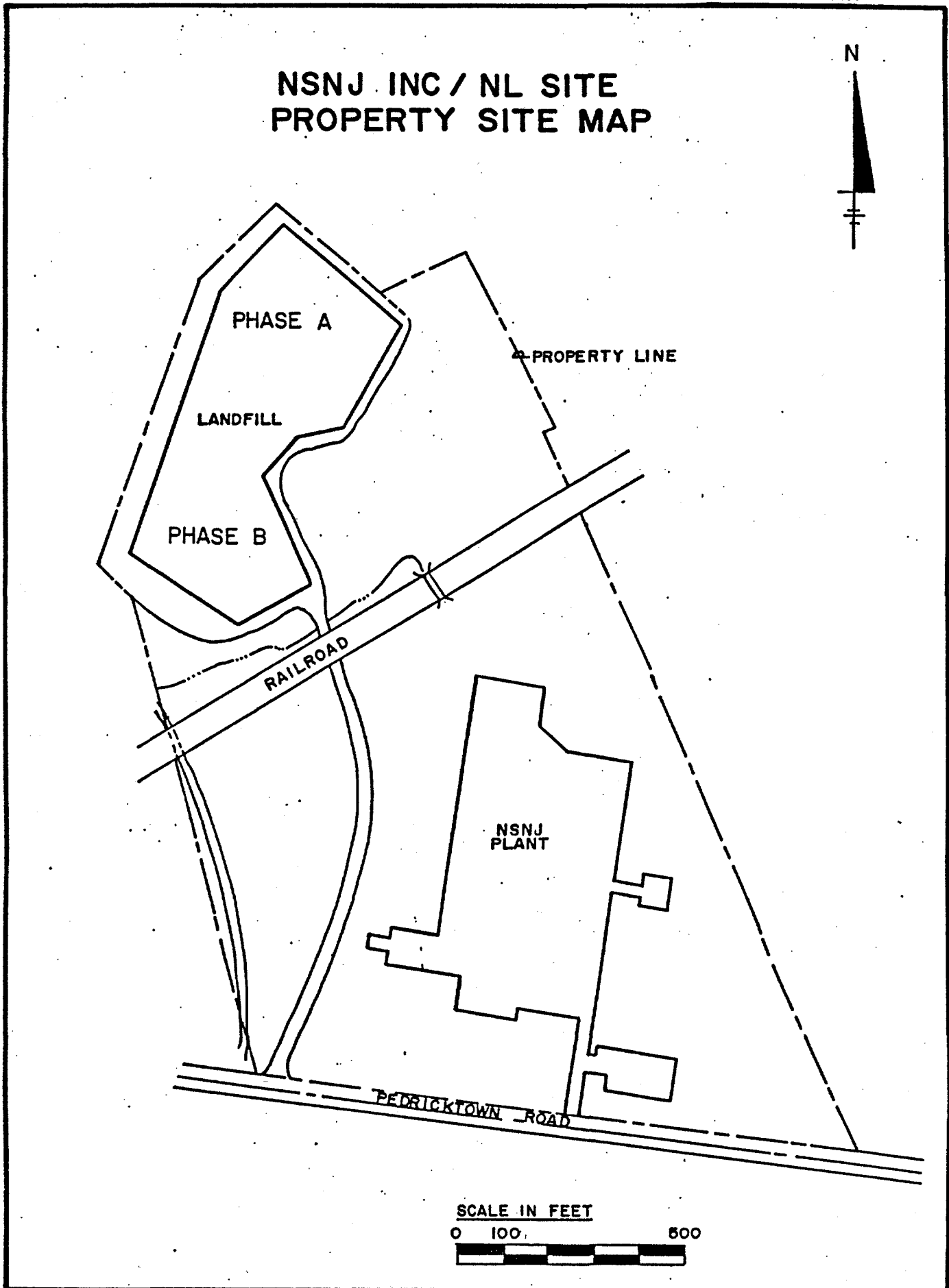
1. Project Location Map
2. Plant Area Map
3. Property Site Map
4. Philadelphia Wind Rose
5. Surface Water/Sediment Sample Location Map (1988 & 1989)
6. Aerial Photo with Sampling Locations
7. On-Site Soil Sample Location Map
8. Surface Soil Analyses
9. Drawdown Test - Drawdown Cycle
10. Drawdown Test - Recovery Cycle
11. Tidal Height - October, 1988
12. Tidal Height - November, 1988
13. Barometric Pressure - October, 1988
14. Barometric Pressure - November, 1988
15. Geologic Cross-Sections
16. Geologic Cross-Section A-A'
17. Geologic Cross-Section B-B'
18. Geologic Cross-Section C-C'
19. Geologic Cross-Section D-D'
20. Unconfined Aquifer Shallow Zone Contour Map 12/88
21. Unconfined Aquifer Shallow Zone Contour Map 12/89
22. First Confined Aquifer Contour Map 12/88
23. First Confined Aquifer Contour Map 12/89

FIGURE 1



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FIGURE 3



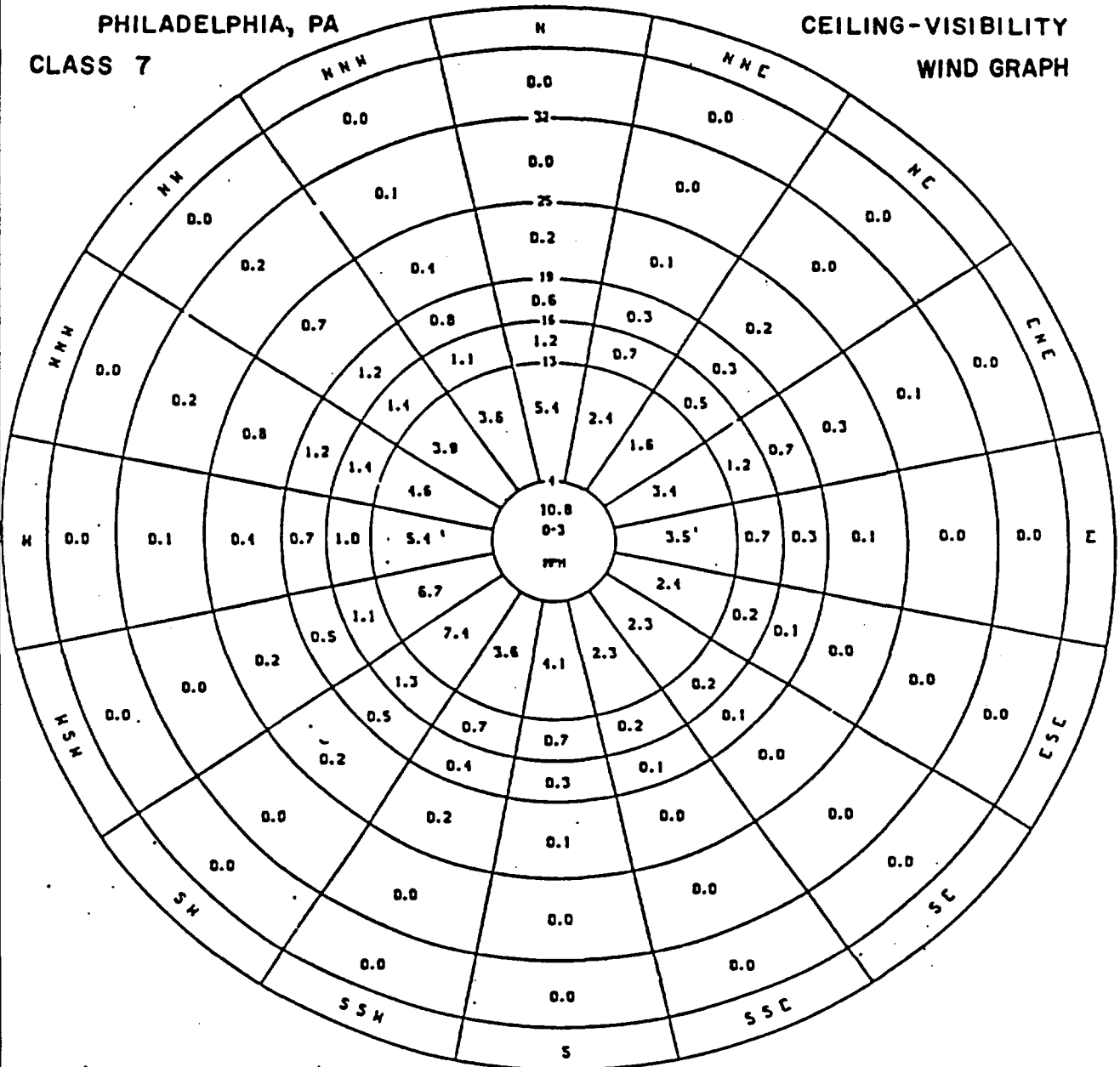
083397

FIGURE 4

WIND ROSE FOR PHILADELPHIA, PA

PHILADELPHIA, PA
CLASS 7

CEILING-VISIBILITY
WIND GRAPH



SOURCE: NATIONAL WEATHER SERVICE
PHILADELPHIA, PA

053397

NSNJ INC / NL SITE **SURFACE WATER/SEDIMENT** **SAMPLING LOCATIONS** **(1988 & 1989)**

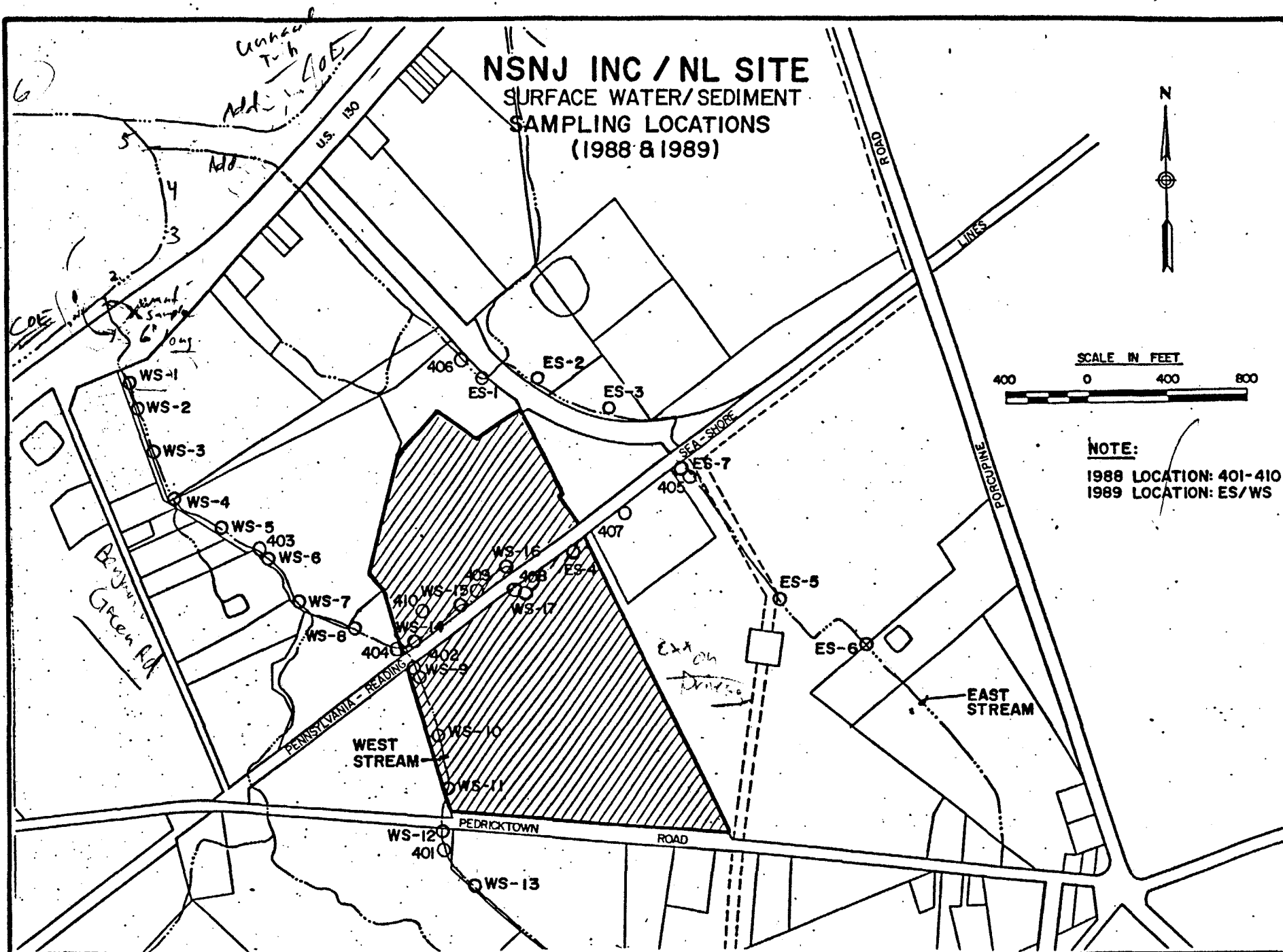


FIGURE 5

EPA REGION II
SCANNING TRACKING SHEET

DOC ID # 54384

DOC TITLE/SUBJECT:

FIGURE 6

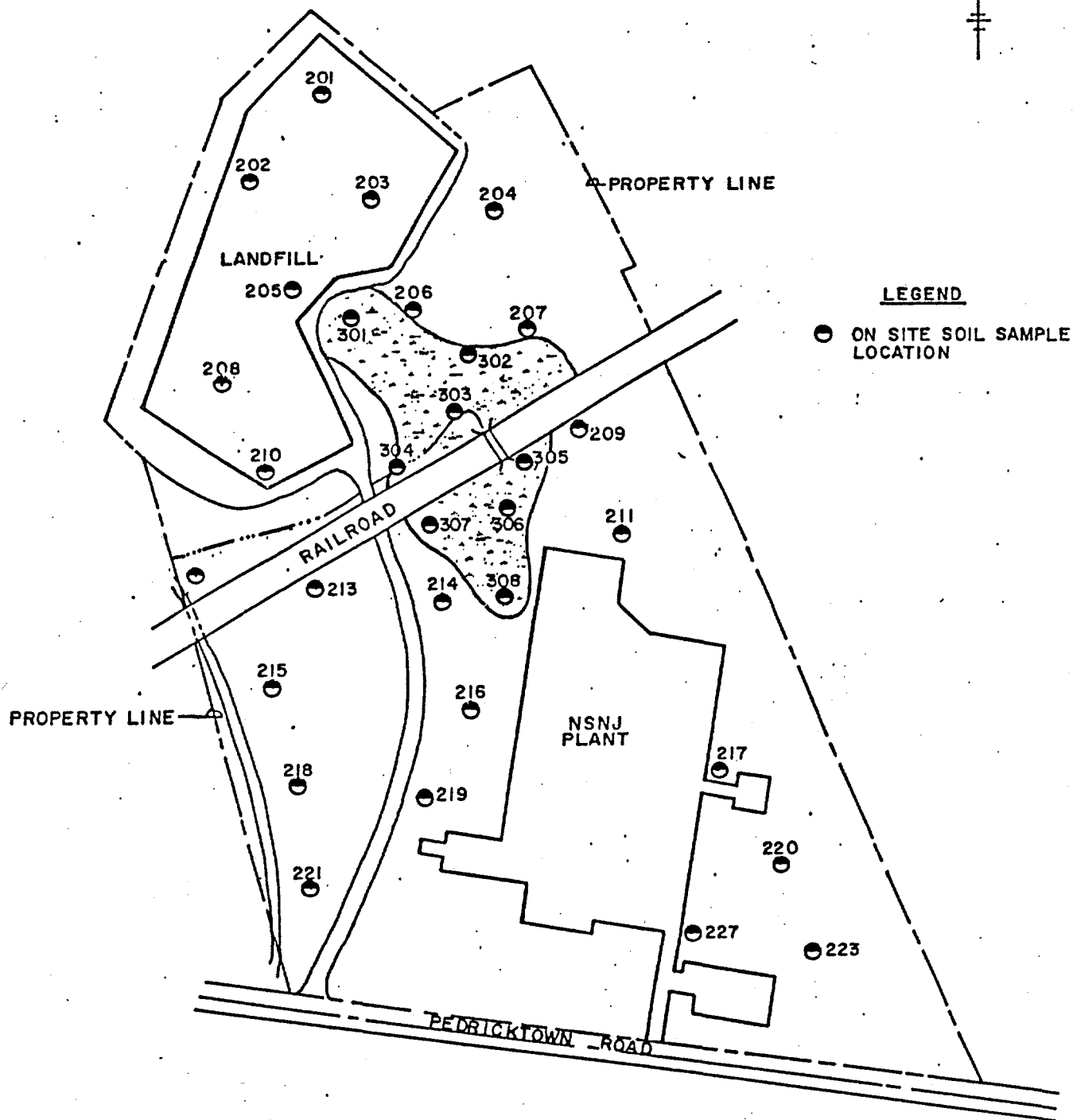
1982

AERIAL PHOTOGRAPH

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NSNJ INC / NL SITE ON-SITE SOIL SAMPLE LOCATION MAP

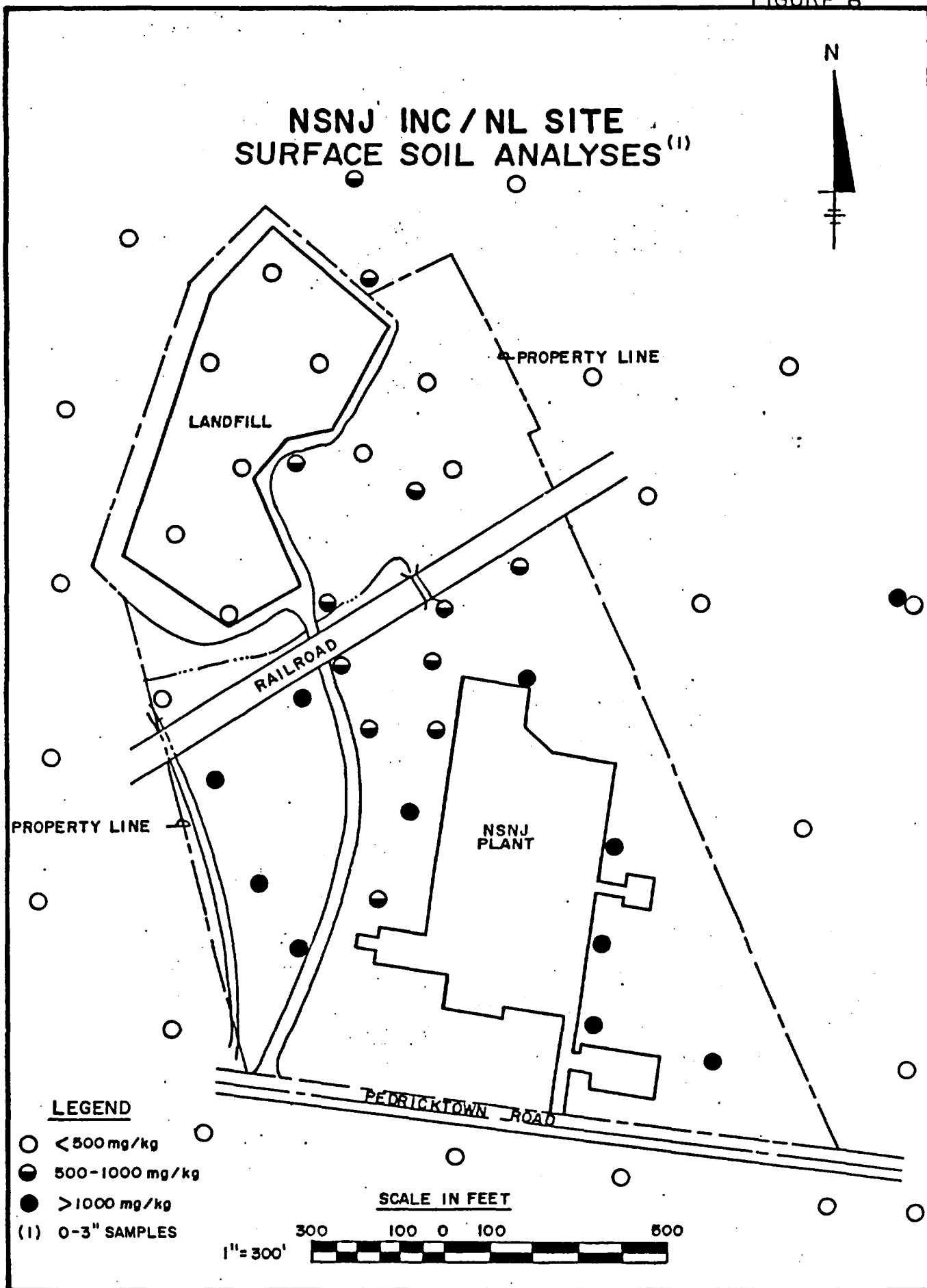


SCALE IN FEET



063397

FIGURE 8



063357

NSNJ INC / NL SITE
DRAWDOWN TEST - DRAWDOWN CYCLE
MONITORING WELL 7 GROUND WATER ELEVATION
DURING DRAWDOWN CYCLE OF WELL #12
OCTOBER 18, 1988

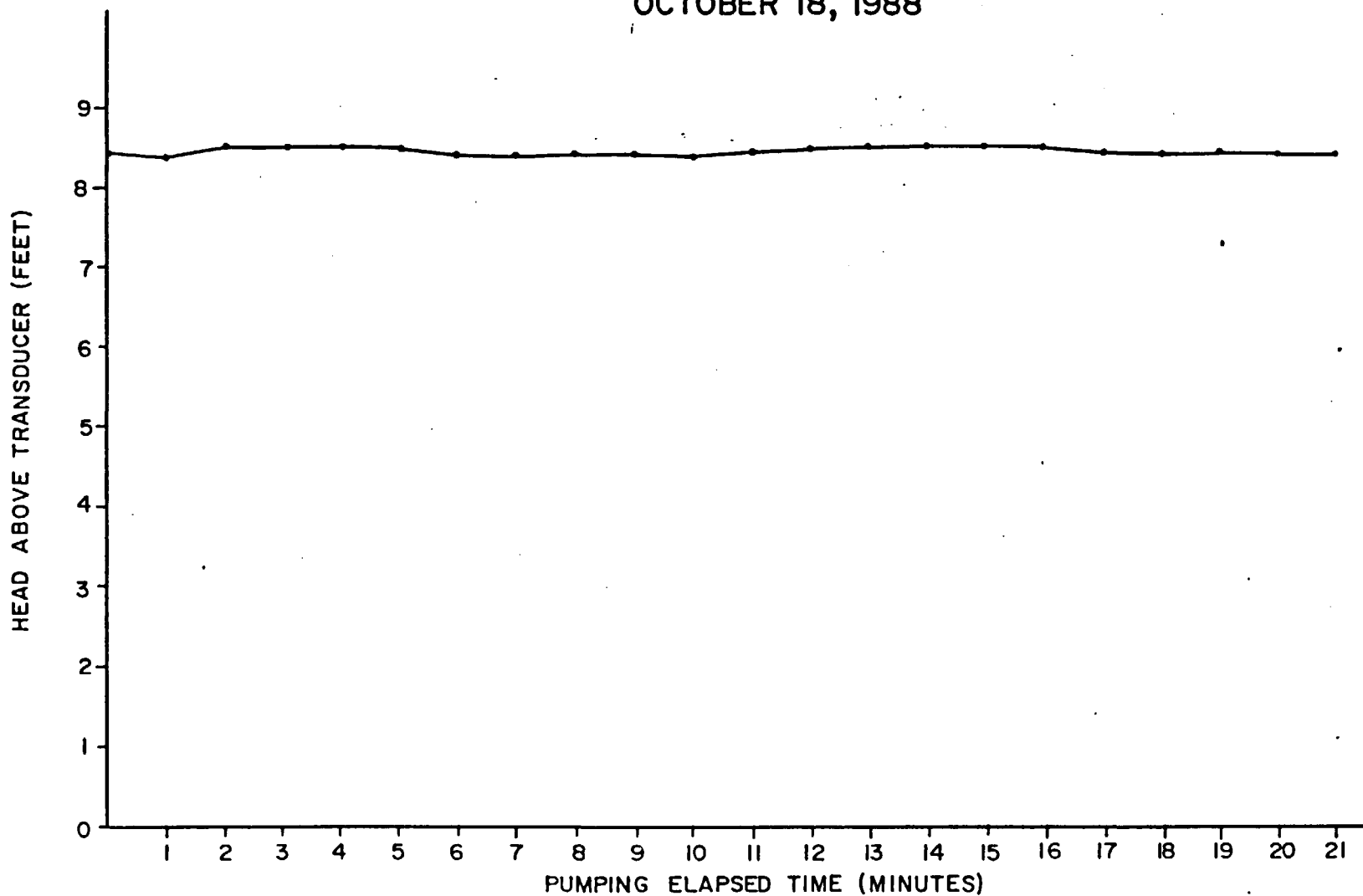


FIGURE 9

NSNJ INC / NL SITE
DRAWDOWN TEST-RECOVERY CYCLE
WATER ELEVATIONS FOR WELLS 12 AND 7
OCTOBER 18, 1988

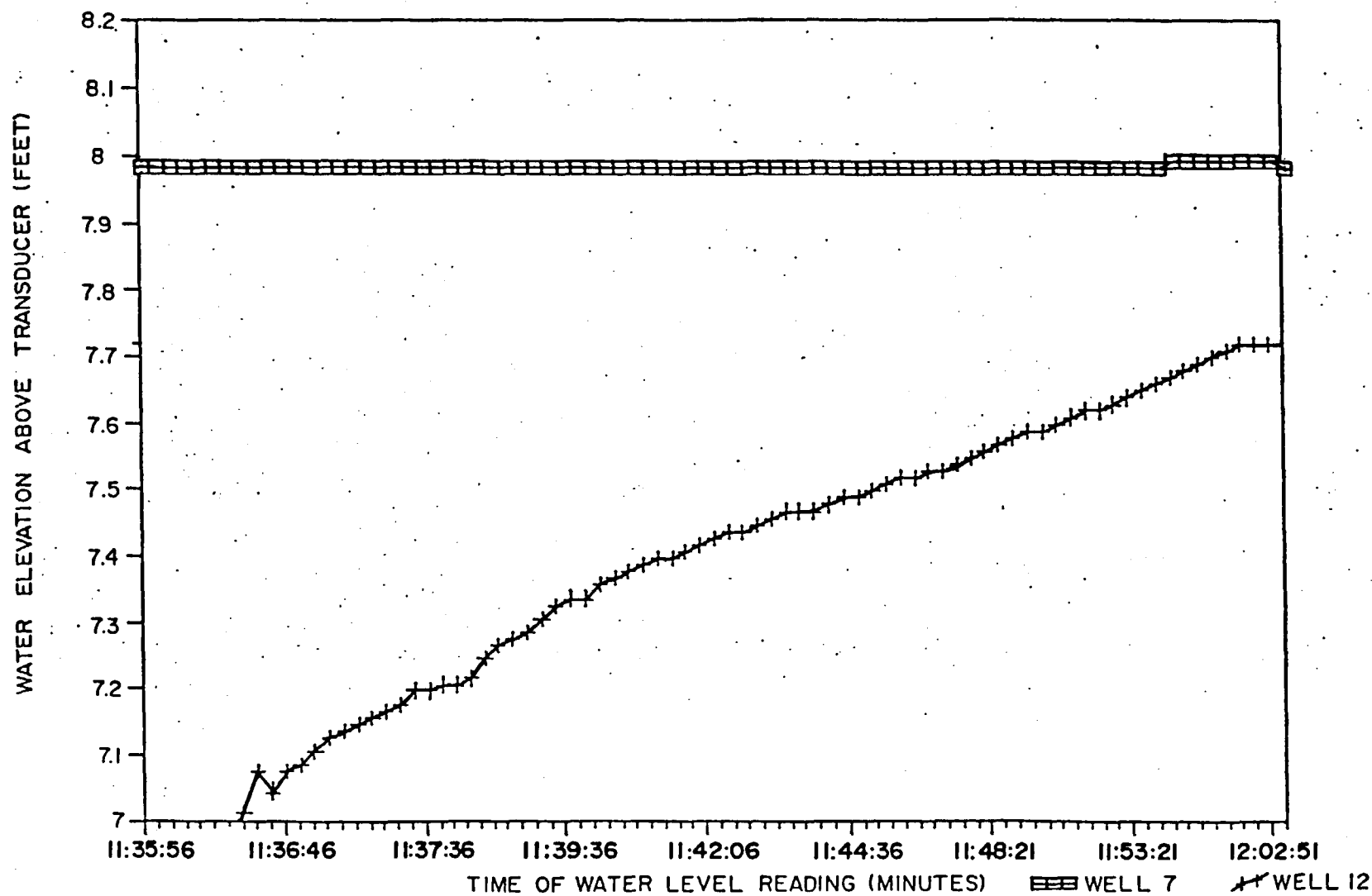
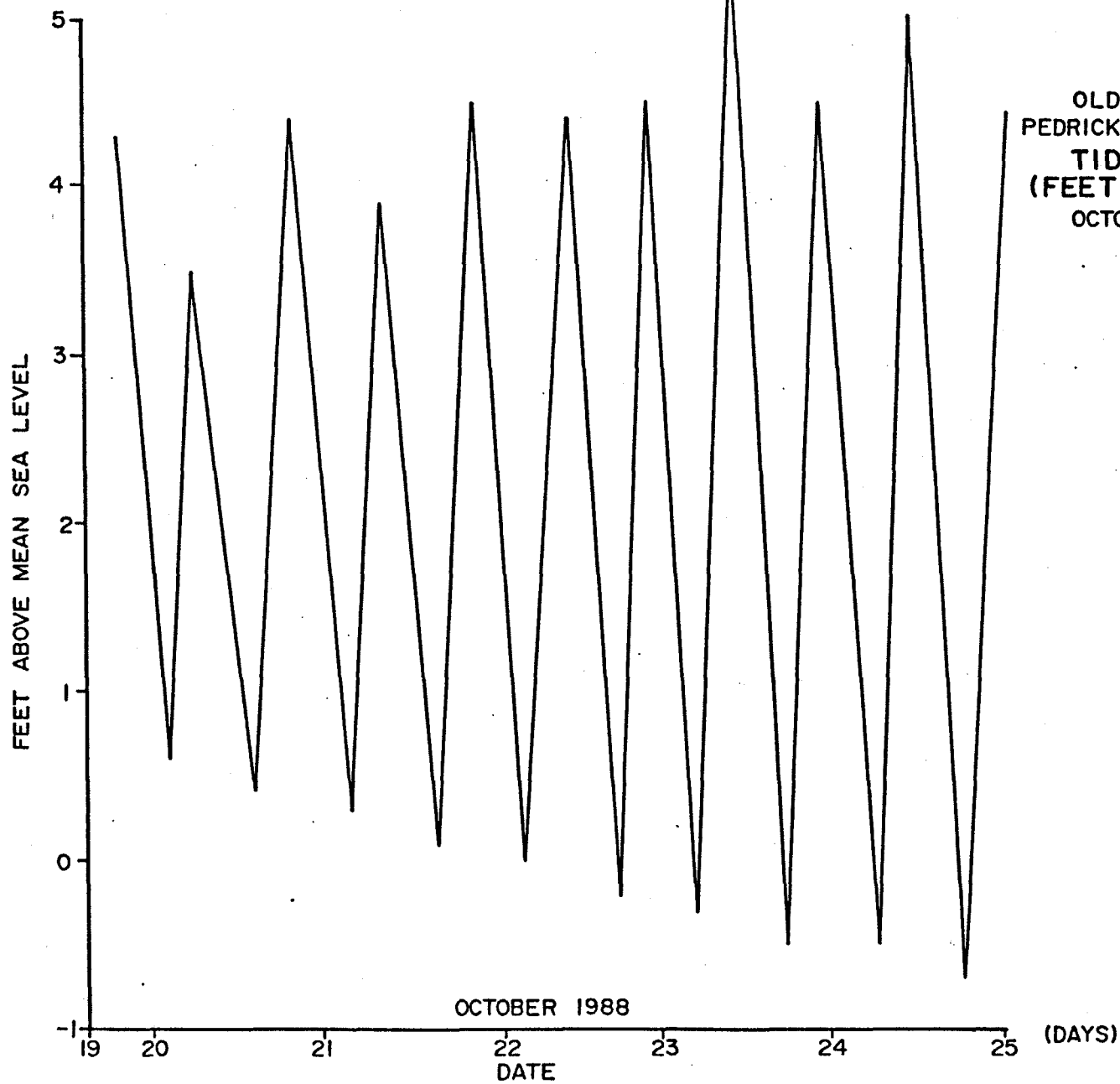
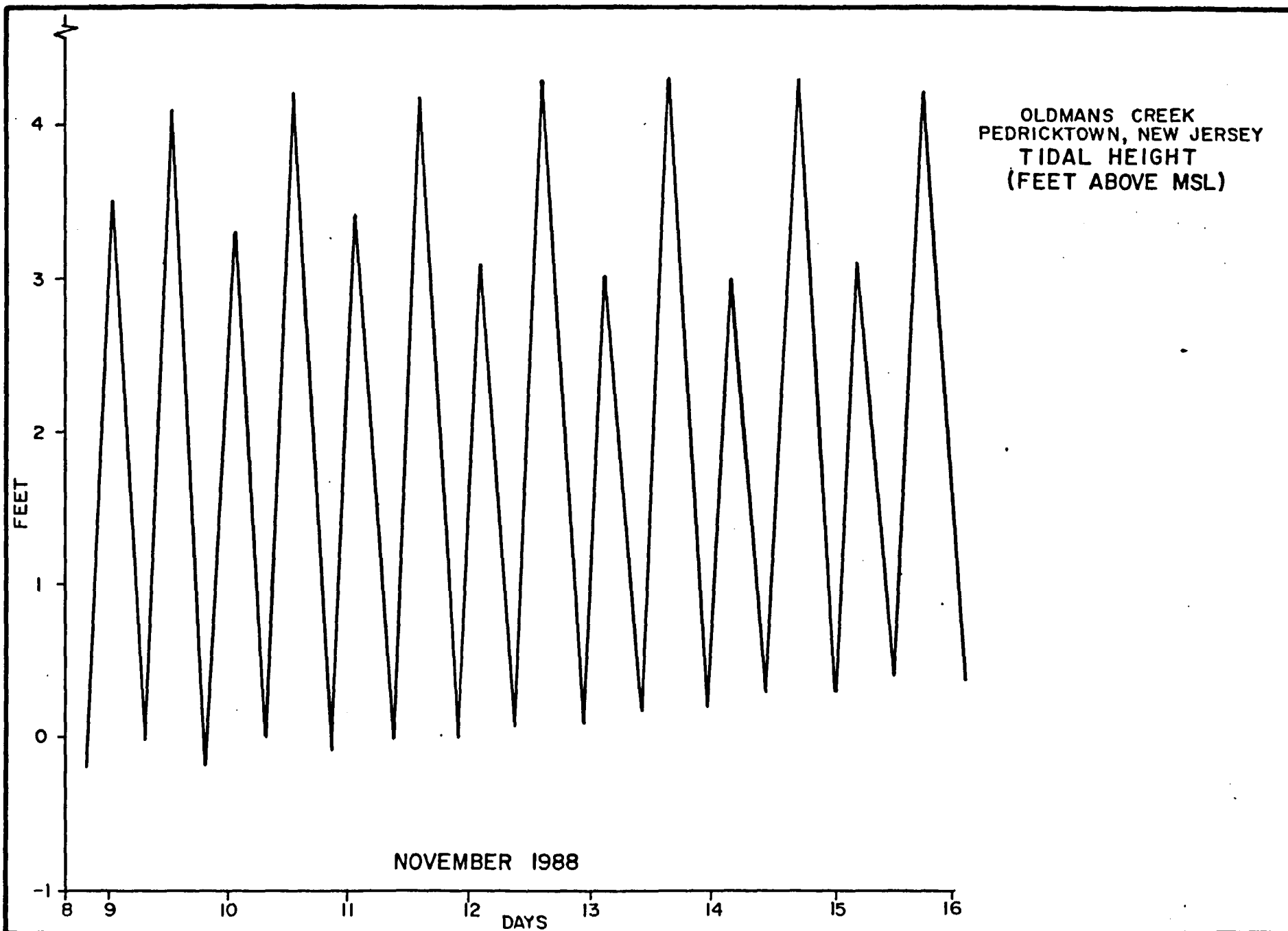


FIGURE 10



NLI 001 1661

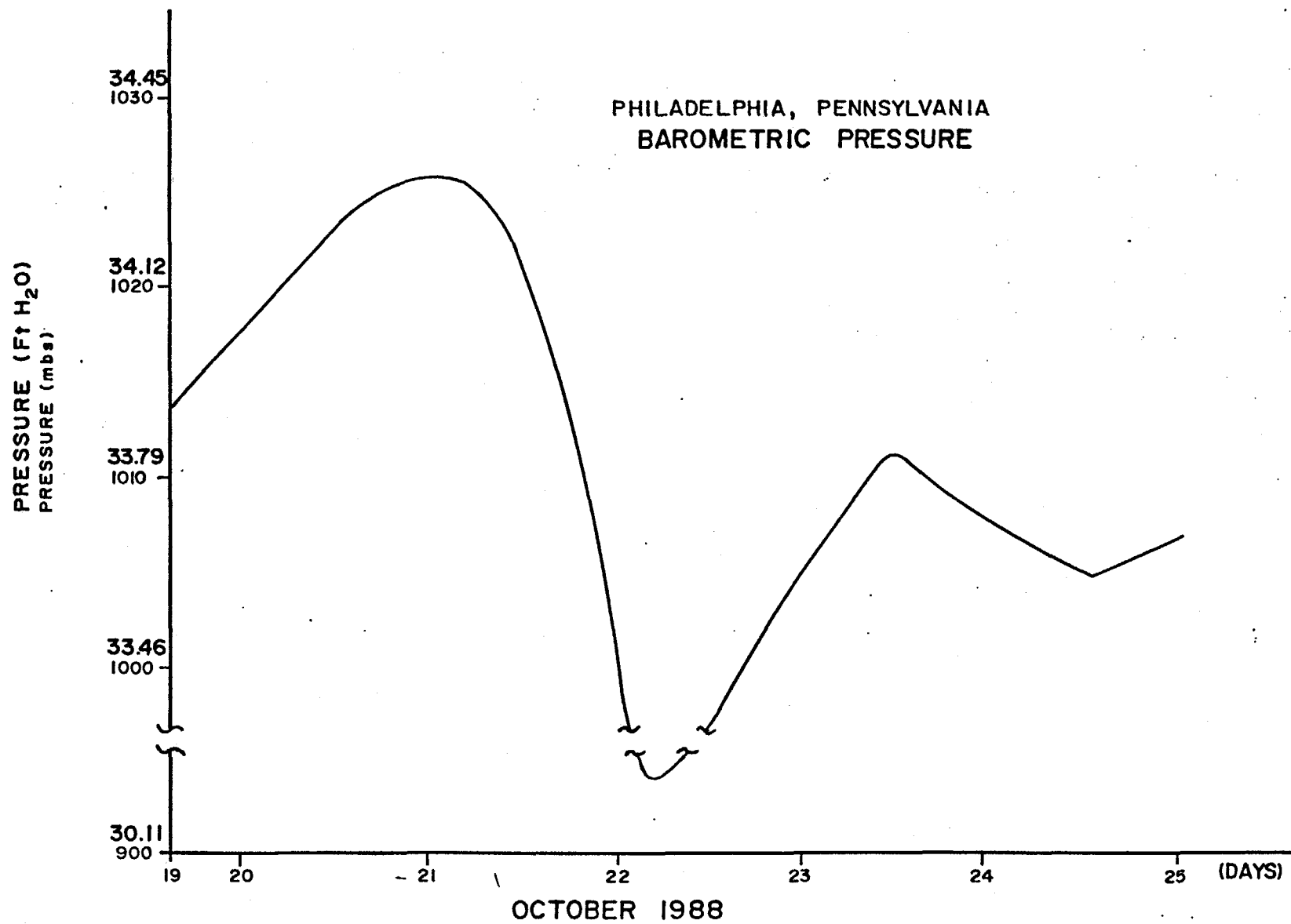
063397



NLI 001 1662

 O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 12



NLI 001 1663

063397

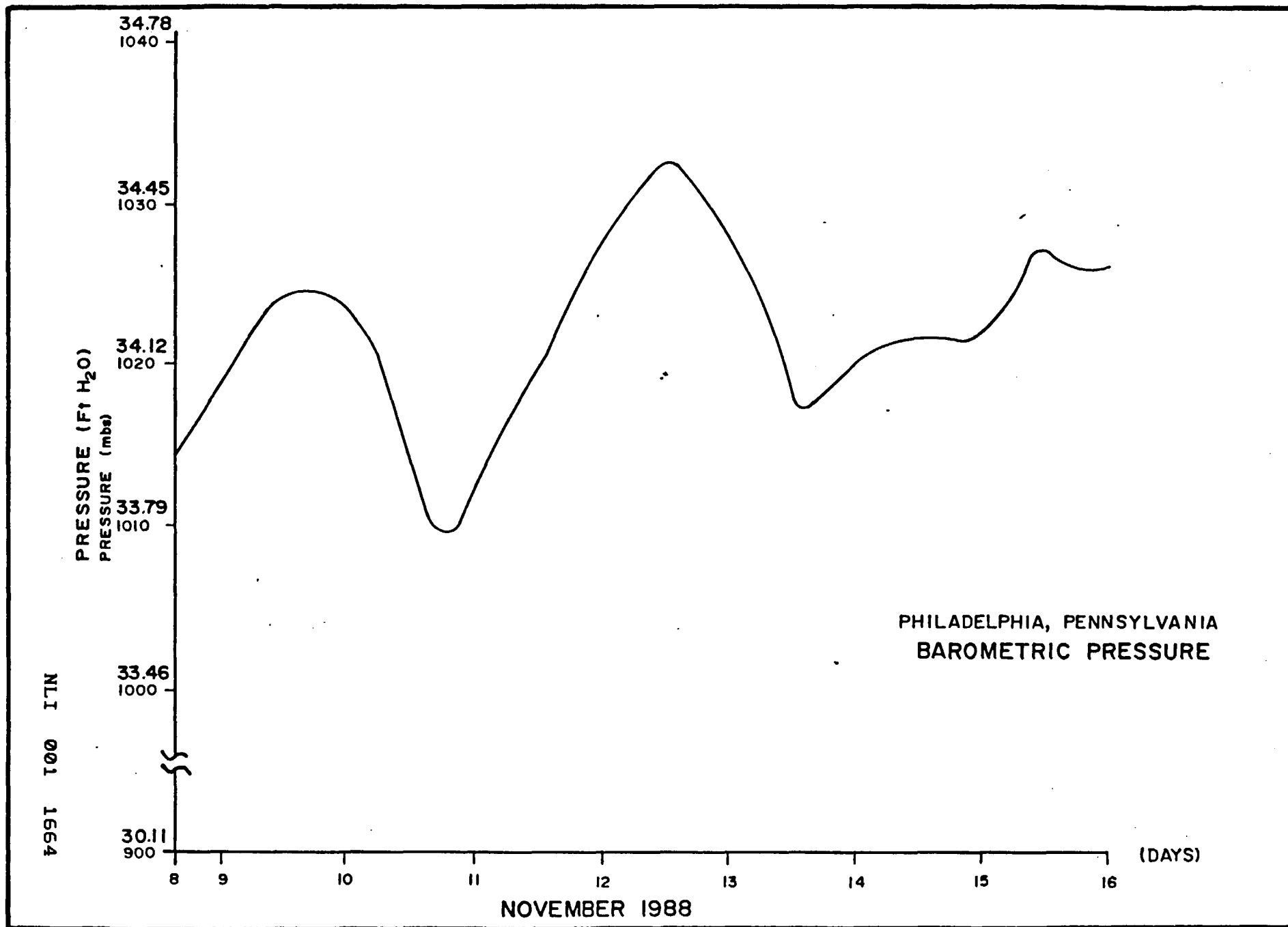
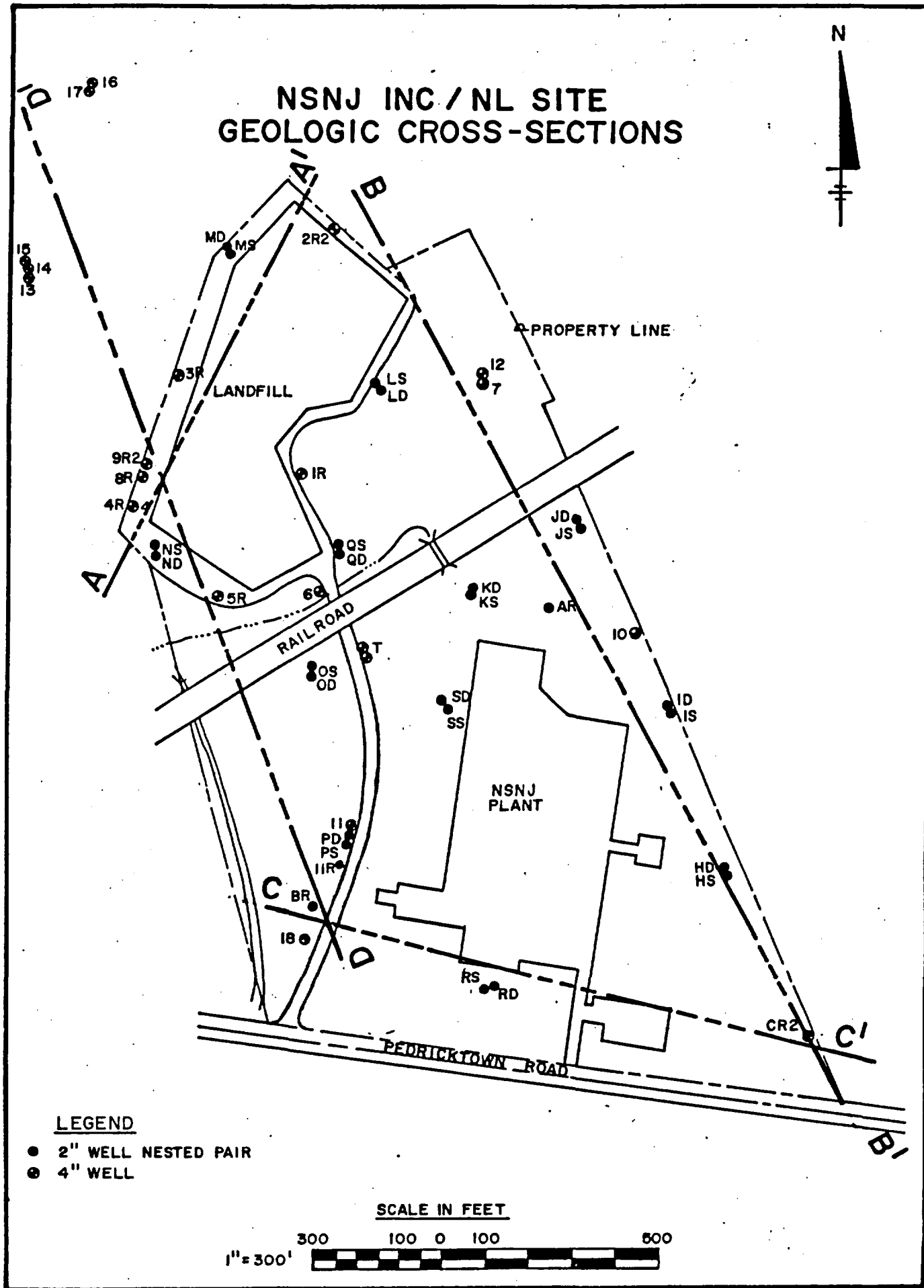
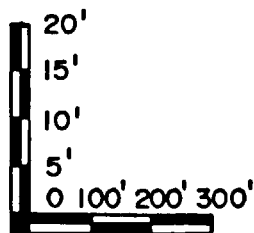


FIGURE 14



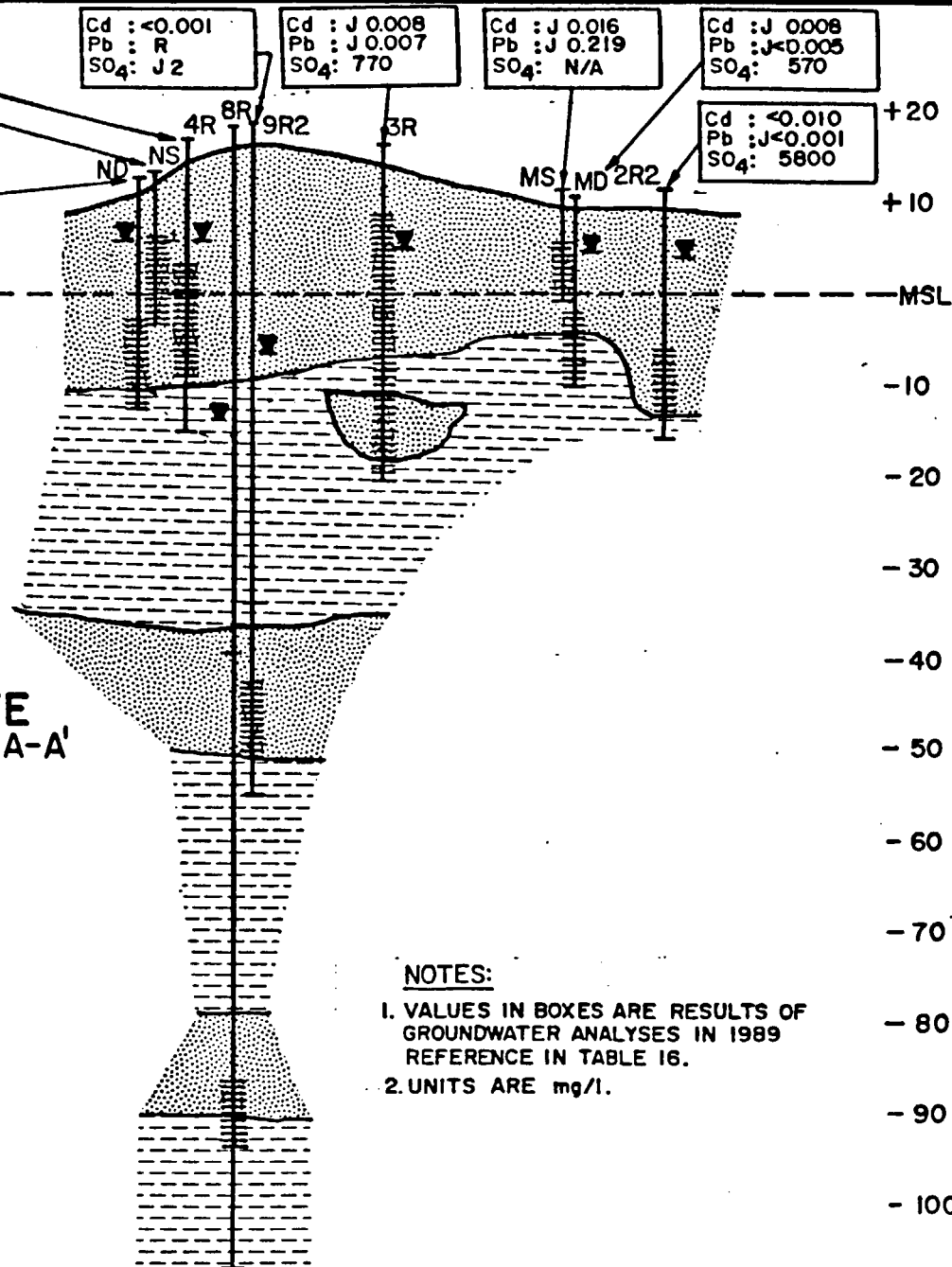
063397

NSNJ INC / NL SITE GEOLOGIC CROSS-SECTION A-A'



SCALE:
HORIZONTAL: 1" = 300'
VERTICAL: 1" = 20'

NLI 001 1666



NOTES:

1. VALUES IN BOXES ARE RESULTS OF GROUNDWATER ANALYSES IN 1989 REFERENCE IN TABLE 16.
2. UNITS ARE mg/l.

LEGEND:

- CLAY
- SAND
- MSL - MEAN SEA LEVEL
- SCREEN INTERNAL
- BOTTOM OF BORING
- GROUNDWATER ELEVATION

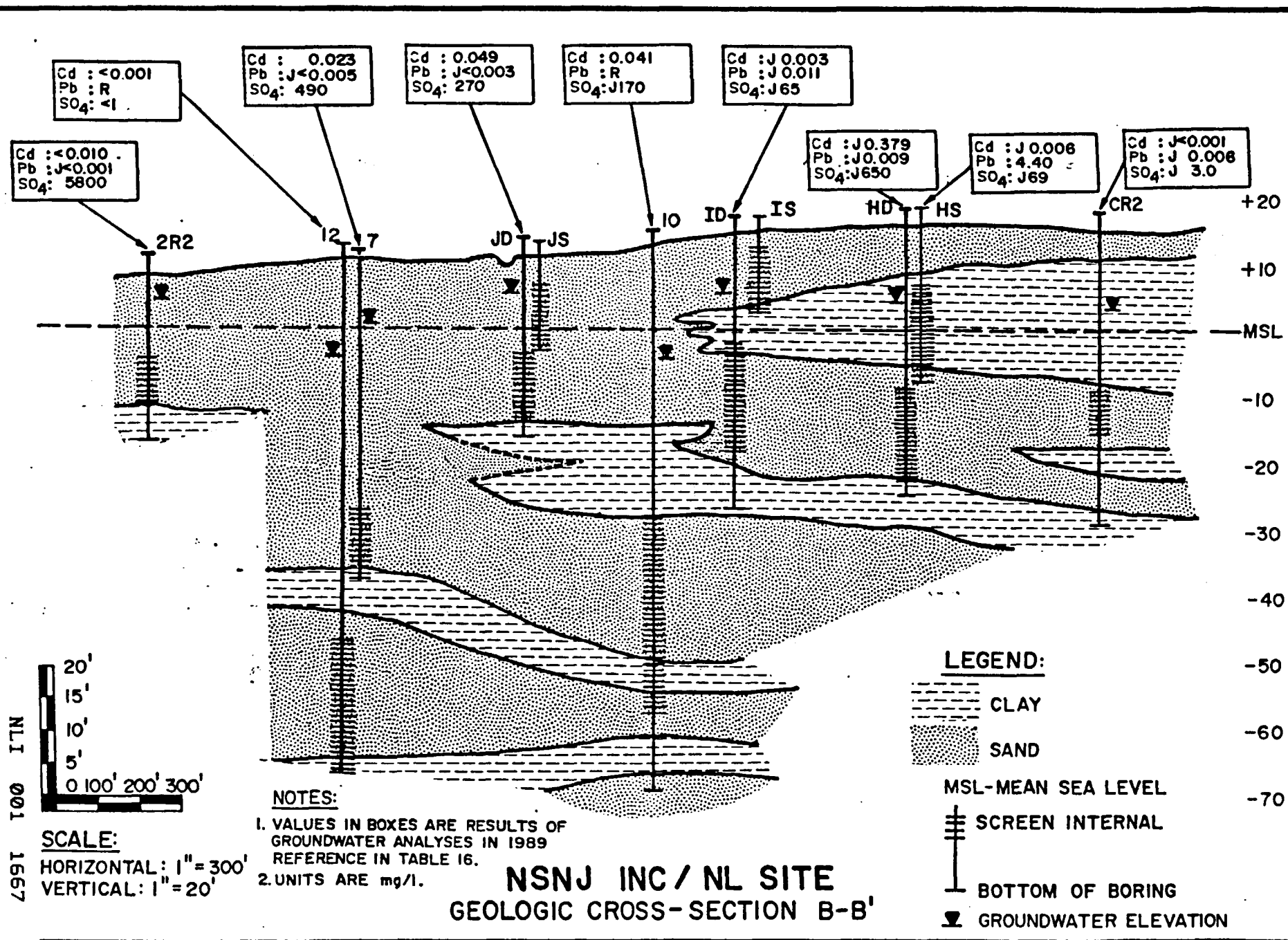
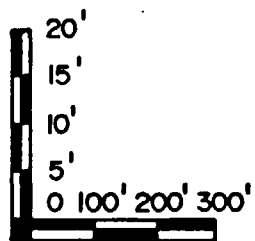
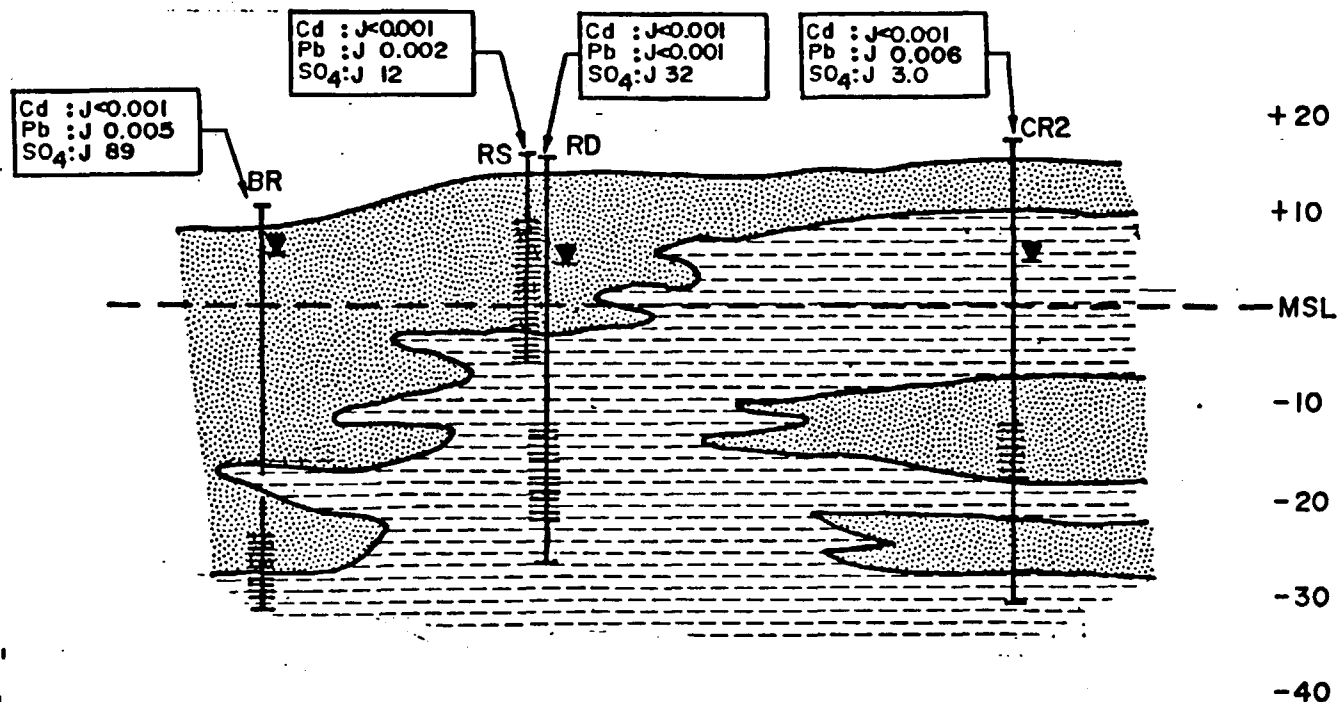


FIGURE 17

NSNJ INC / NL SITE GEOLOGIC CROSS-SECTION C-C'



SCALE:

HORIZONTAL: 1" = 300'
VERTICAL: 1" = 20'

NOTES:

- VALUES IN BOXES ARE RESULTS OF GROUNDWATER ANALYSES IN 1989 REFERENCE IN TABLE 16.
- UNITS ARE mg/l.

LEGEND

MSL - MEAN SEA LEVEL

CLAY

SAND

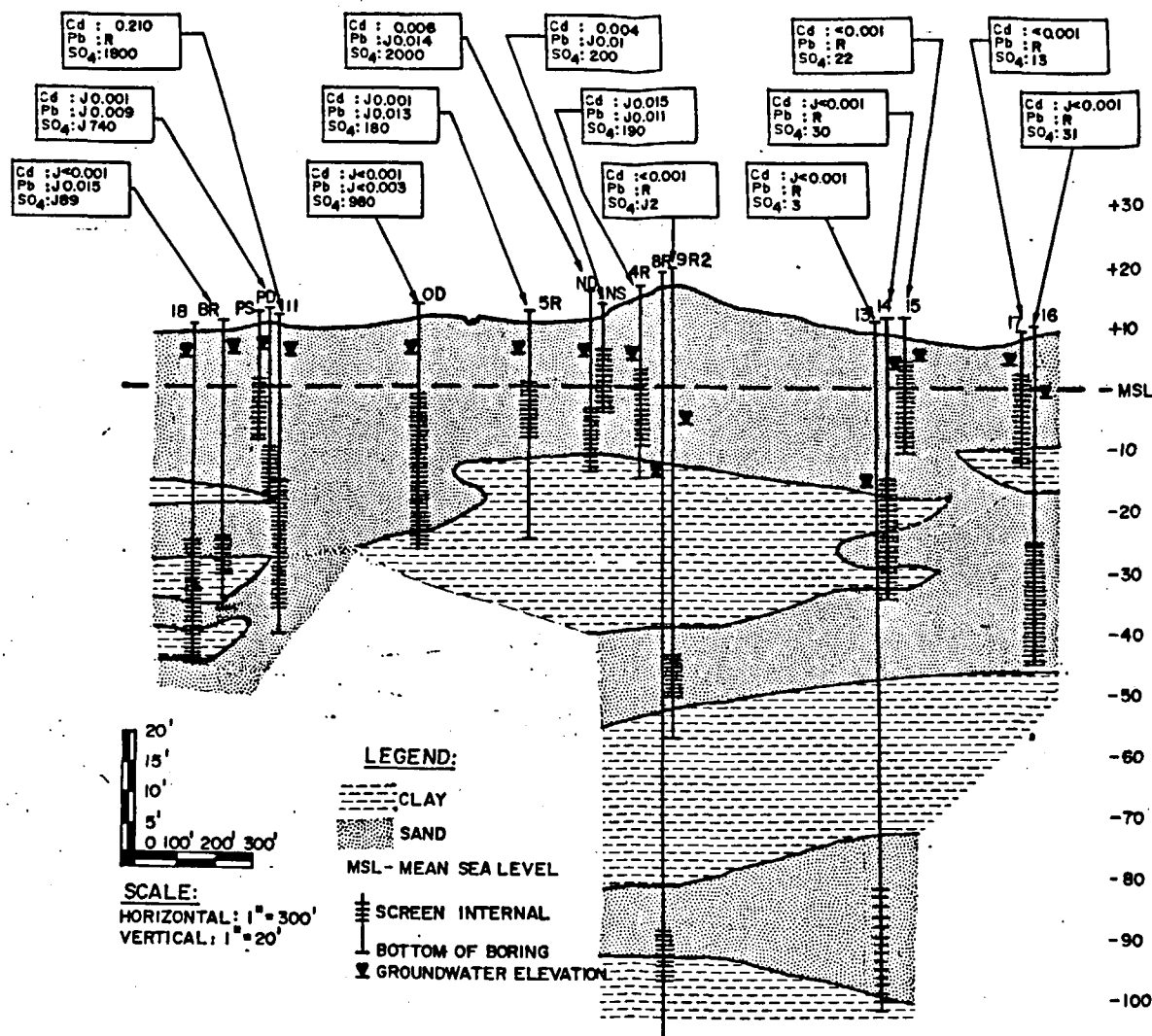
SCREEN INTERNAL

BOTTOM OF BORING

GROUNDWATER ELEVATION

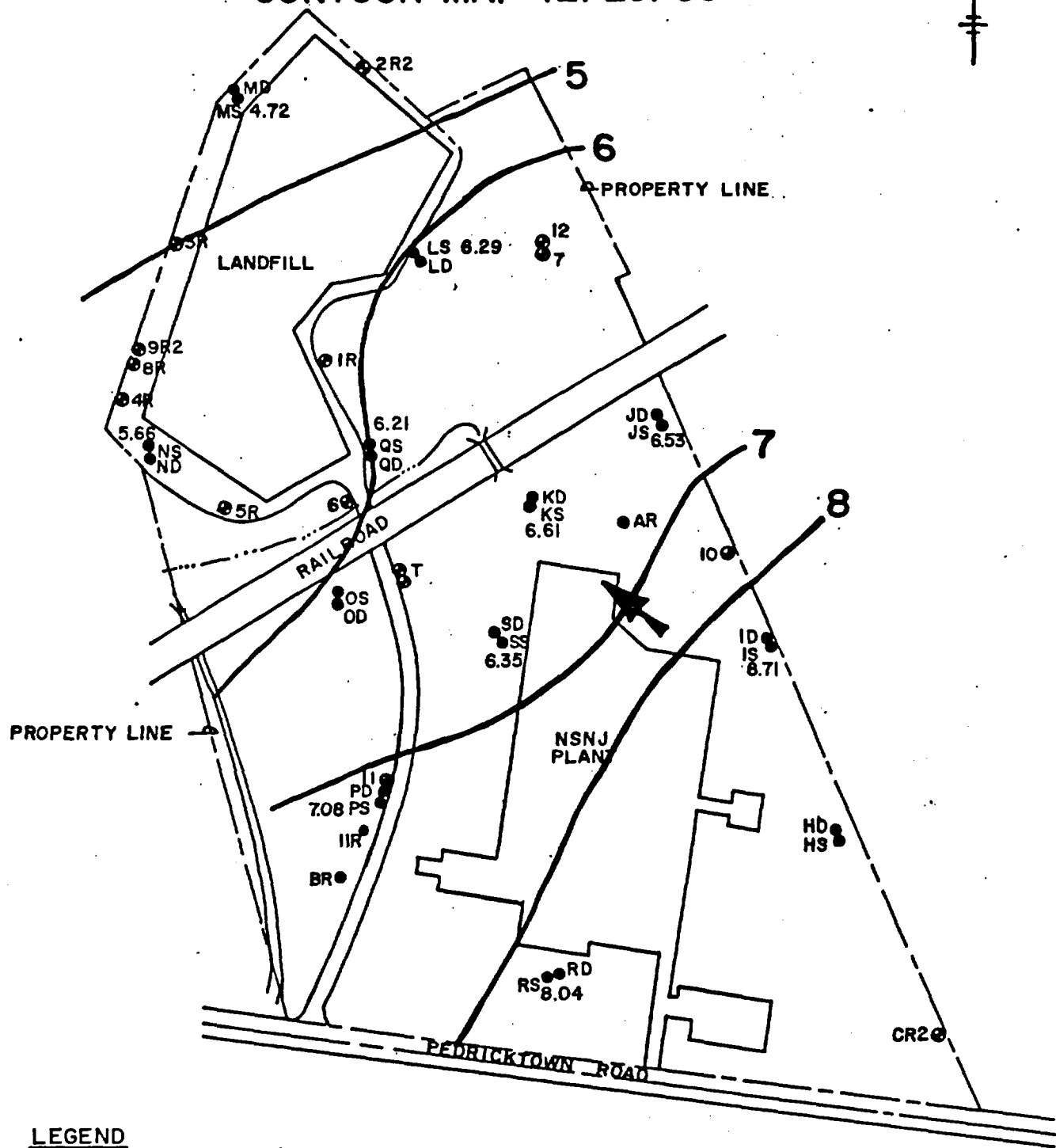
NLI 001 1668

FIGURE 19



NLI 001 1669

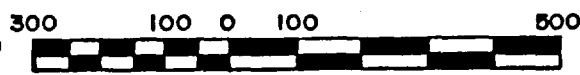
NSNJ INC / NL SITE UNCONFINED AQUIFER SHALLOW ZONE CONTOUR MAP 12/23/88



LEGEND

- 2" WELL NESTED PAIR
- 4" WELL
- 5.66 GROUNDWATER ELEVATION
- GROUNDWATER CONTOUR
- ↑ GROUNDWATER FLOW DIRECTION

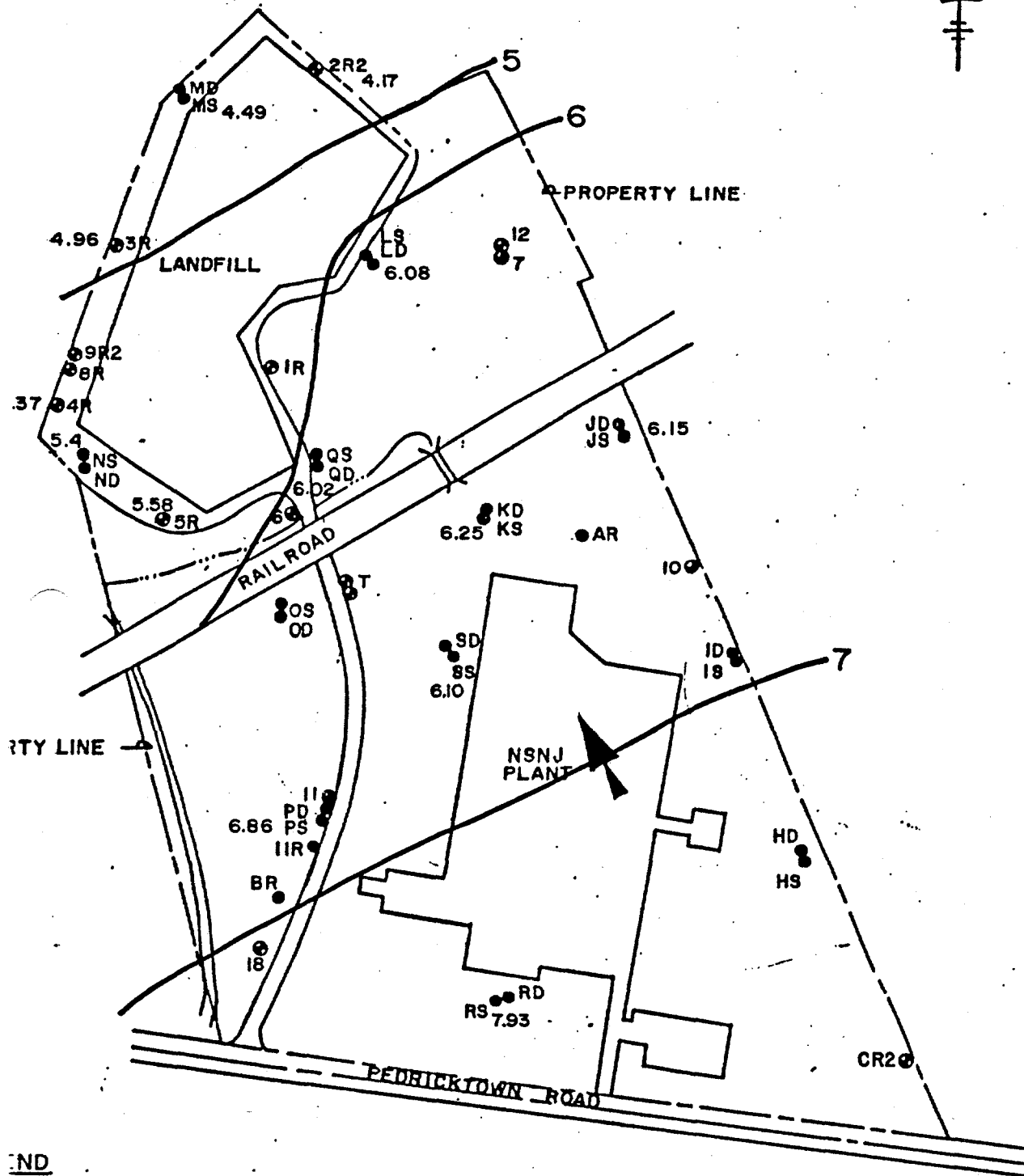
SCALE IN FEET



NLI 001 1670

083397

NSNJ INC / NL SITE UNCONFINED AQUIFER SHALLOW ZONE CONTOUR MAP 12/23/89



END
ALL NESTED PAIR
WELL
WATER ELEVATION
WATER CONTOUR
WATER FLOW
STATION

SCALE IN FEET



NLI 001 1671

NSNJ INC / NL SITE FIRST CONFINED AQUIFER CONTOUR MAP 12/23/88

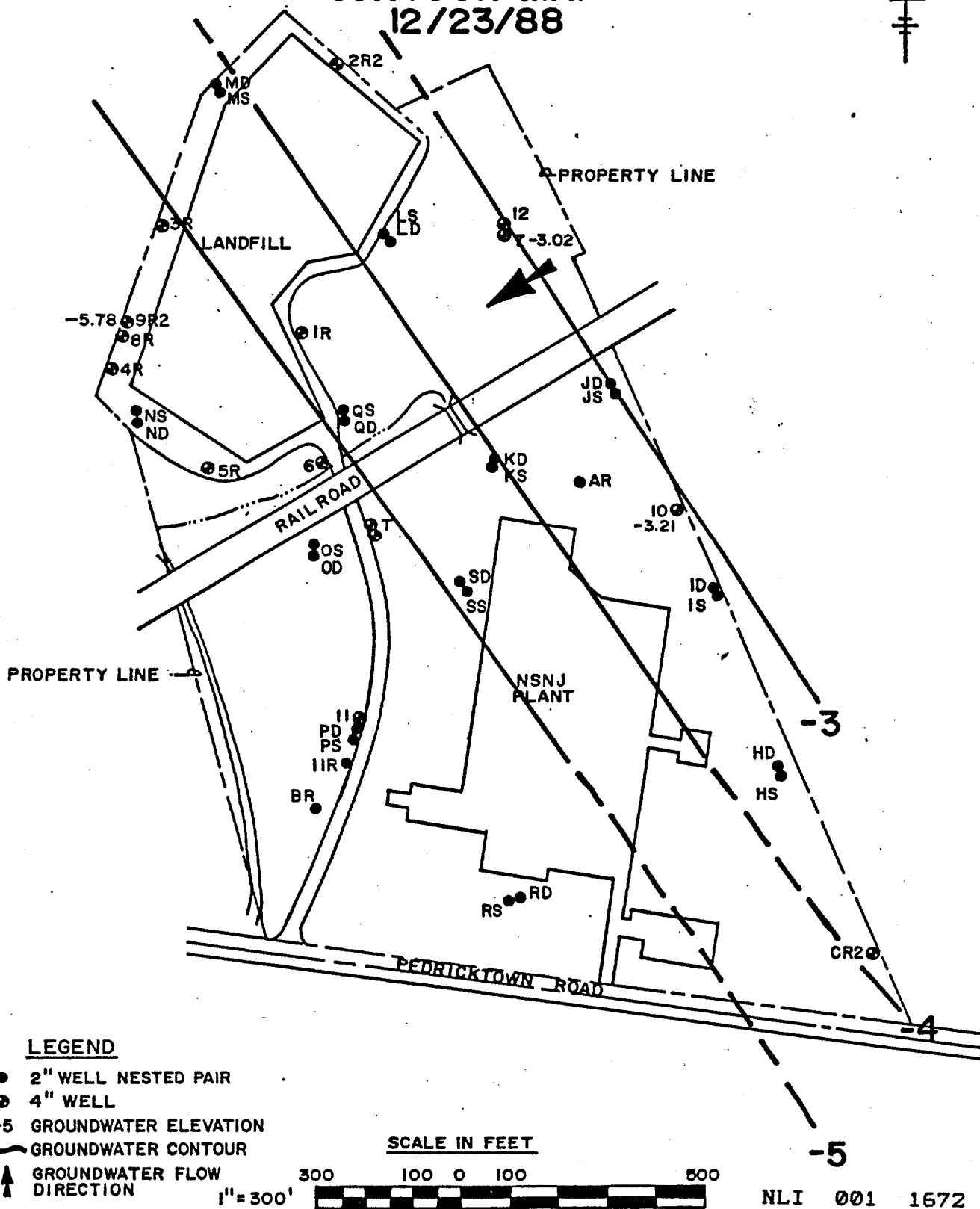


FIGURE 23

NSNJ INC / NL SITE FIRST CONFINED AQUIFER CONTOUR MAP 12/23/89

